DECLARATION

I, YUZURU OKABE, a Japanese Patent Attorney registered No. 9411, of Okabe International Patent Office at No. 602, Fuji Bldg., 2-3, Marunouchi 3-chome, Chiyoda-ku, Tokyo, Japan, hereby declare that I have a thorough knowledge of Japanese and English languages, and that the attached pages contain a correct translation into English of the priority documents of Japanese Patent Application No. 5-157582 filed on June 28, 1993 in the name of CANON KABUSHIKI KAISHA.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made, are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 6th day of March, 2002

YUZURU OKABE

PATENT OFFICE
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[Title of the Invention] Ink-jet Recording Apparatus

[What is Claimed is]

[Claim 1]

An ink-jet recording apparatus for using inks of at least two types of coloring materials, the ink of each coloring material being classified so that it has at least two different coloring material densities, having a plurality of ink discharge means for forming dots on a material to be recorded on by discharging the inks from the different ink discharge ports, which correspond to the plural inks, and controlling the number of recording dots per unit area, which are discharged onto the material to be recorded on in accordance with an image signal, thereby permitting gradational recording, characterized in that:

the ink cartridges, which hold the inks to be supplied to the ink discharge means, is grouped by the ink of the same type of coloring material.

[Claim 2]

An ink-jet recording apparatus for useing inks of different densities, having an ink discharge means, which discharges inks with different densities through different ink discharge ports corresponding to the inks of the plural densities to form dots on a material to be recorded on, and controlling the number of recording dots per unit area in accordance with an image signal, thereby permitting

gradational recording, characterized in that:

the ink capacity of a cartridge, which supplies the ink to the ink discharge means, being different according to the predicted volume to be use of each ink.

[Claim 3]

The ink-jet recording apparatus according to claim 1 or 2, wherein said used ink-jet recording head is adapted to use heat energy to discharge an ink from a discharge port, and there is further provided an electrothermal energy converting member serving as means for generating the heat energy.

[Detailed Description of the Invention]

[0001]

[Field of the Industrial Utilization]

The present invention relates to an ink-jet recording apparatus which uses inks formed of coloring materials of at least two kinds are employed, ink of each of which coloring material being classified to have coloring material densities of at least two kinds, comprises a plurality of ink discharge means for forming dots a recording medium by discharging respective inks from different ink discharging ports respectively corresponding to the plurality of inks, and controls the number of recording dots per unit area to be discharged onto the recording medium in response to an image signal, so as to perform gradation recording.

[0002]

[Prior Art]

In the conventional ink-jet recording method, ink is discharged from a plurality of ink discharge ports, which are formed in a recording head, in accordance with data signals and the ink droplets are caused to adhere to a material to be recorded on such as paper. This recording method is employed for a printer, facsimile, and copier, for example.

[0003]

In the aforesaid apparatus, there are methods available, including one using an electrothermal energy converter, wherein a heating device (electrothermal energy transducer) is provided for discharging ink, in the vicinity of a discharge port, and an electrical signal is applied to the heating device to heat the ink locally to cause pressure change, thereby discharging the ink through the discharge port, and another method wherein an electromechanical transducer such as a piezoelectric device.

[0004]

In this type of recording method, the recording control for medium tone according to a dot density control method, wherein the number of recording dots per unit area is controlled by a recording dot of a fixed size for gradation recording in order to represent the medium tone, or a dot diameter control method, wherein the size of the recording dot is controlled to represent the medium tone is carried out. The latter dot diameter control method has

restrictions because it requires complicated control; therefore, the former dot density control method is commonly used.

[0005]

Further, the use of the electrothermal energy converter, which can be manufactured more easily and which permits higher density and accordingly higher resolution, as the ink discharging means, makes it difficult to control a pressure variation and also makes it impossible to change the diameter of the recording dot. For this reason, the dot density control method is used.

[0006]

There is a systematic dither method as one of the typical binary techniques for representing medium tone used for the dot density control method, however, this method is disadvantageous in that the number of gradation levels is limited by a matrix size. To be specific, to increase the number of gradation levels, it is necessary to increase the matrix size, but increasing the matrix size causes a picture element of a recorded image comprised of a single matrix to grow larger with resultant lower resolution, thus posing problems. There is a conditioned decisive dither method such as an error diffusion method as another typical binary technique. This is a method, wherein a threshold value is changed, considering a peripheral picture element of an input picture element, while the aforesaid systematic dither method is an independent decisive dither method,

wherein a threshold value, which is independent of an input picture element, is used for binarizing. The conditioned decisive dither method represented by this error diffusion method provides such advantages as good compatibility of gradation performance and resolution and minimized chances of a moire pattern occurring in a recorded image when an original image is a printed image, however, it also presented a problem in that grainy look in a lighter part of an image is more noticeable, leading to lower rating of the image quality. This problem was especially marked in a recording apparatus with a lower recording density.

[0007]

To make the grainy look less conspicuous, a recording method has been proposed, wherein the conventional ink-jet recording apparatus is provided with two recording heads which discharge an ink of light color and an ink of dark color; recording dots are formed with the ink of the low dye density for the light to medium tone parts of the image and the recording dots are formed with the ink of the dark color for the medium to dark parts.

[0008]

Fig. 21 shows a configuration diagram of a major section of the conventional color ink-jet recording apparatus of a serial print type which uses dark and light inks. Installed on a carriage with predetermined intervals are a recording head Kk, which discharges a dark black ink, a recording head Ku, which discharges a light black ink,

a recording head Ck, which discharges a dark cyan ink, a recording head Cu, which discharges a light cyan ink, a recording head Mk, which discharges a dark magenta ink, a recording head Mu, which discharges a light magenta ink, a recording head Yk, which discharges a dark yellow ink, and a recording head Yu, which discharges a light yellow ink.

[0009]

The inks for the individual recording heads are supplied from ink cartridges 248 corresponding to the individual colors. Further, the control signals to the recording heads are supplied via a flexible cable 249.

[0010]

A material to be recorded on consisting of paper or a plastic thin plate is held by delivery rollers 21 via carrying rollers (not shown) and carried in the direction of the arrow as a carrying motor, which is not shown) runs. A carriage 23 is guided and supported by a guide shaft 22 and an encoder (not shown). The carriage is also shuttled by a carriage motor 25 along the guide shaft 22 mentioned above.

[0011]

A heating device (electrothermal energy converter), which generates heat energy for discharging an ink is provided inside (liquid passage) the ink discharge port of the ink-jet unit described above. An image can be formed by driving the heating device in accordance with recording

signals and the reading timing of the encoder to jet and deposit ink droplets onto a material to be recorded on in the order of the dark black, light black, dark cyan, light cyan, dark magenta, light magenta, dark yellow, and light yellow. A restoring unit 240 with caps 247 is disposed in a home position of the carriage, which is selected and located outside a recording area, to maintain ink discharge stability.

[0012]

[Problems to be Solved by the Invention]

The ink-jet recording apparatus, which employed dark and light inks as discussed above, however, requires that dark and light inks be prepared for each color. For example, if four colors are used, then at least eight different inks and ink cartridges must be prepared. In other words, there is a disadvantage in that a user must always keep eight different ink tanks. Accordingly, the apparatus itself unavoidably grows larger with complicated and troublesome change of the cartridges.

[0013]

Furthermore, if there is a significant difference in dot density between the dark and light color inks, then the reproduced gradation cannot be rendered linear in the area where a light ink is taken over by a dark ink, frequently producing a pseudo-contour, or a change in graininess or tone of a recorded image takes place in an ink switching area, resulting in an unnatural image. To solve these

problems, it is more desirable to increase the number of inks by using, for instance, low-density inks, medium-density inks, and high-density inks to perform the recording, however, this is difficult to carry out especially in a color recording apparatus because of the problems described above.

[0014]

It is an object of the present invention to solve the problems with the conventional apparatus described above and provide a small, inexpensive apparatus which features excellent gradation and resolution and which is capable of producing an image with an extremely good graininess, to minimize the number of the ink cartridges for supplying ink to the ink discharge means, and to permit easier operation.

[0015]

[Means for Solving the Problems]

To fulfill the above object, the ink-jet recording apparatus according to the present invention uses inks of at least two types of coloring materials, the ink of each coloring material being classified so that it has at least two different coloring material densities, has a plurality of ink discharge means for forming dots on a material to be recorded on by discharging the inks from the different ink discharge ports, which correspond to the plural inks, and controls the number of recording dots per unit area, which are discharged onto the material to be recorded on

in accordance with an image signal, thereby permitting gradational recording, the ink cartridges, which hold the inks to be supplied to the ink discharge means, being grouped by the ink of the same type of coloring material.

[0016]

Further, the ink-jet recording apparatus according to the present invention uses inks of different densities, has an ink discharge means, which discharges inks with different densities through different ink discharge ports corresponding to the inks of the plural densities to form dots on a material to be recorded on, and controls the number of recording dots per unit area in accordance with an image signal, thereby permitting gradational recording, the ink capacity of a cartridge, which supplies the ink to the ink discharge means, being different according to the predicted volume to be use of each ink.

[0017]

[Mode of Operation]

The tanks holding inks, which are of the coloring materials of the same color but are different in density, are integrated into a single ink cartridge. Therefore, the ink cartridge can be replaced by each type of color. In addition, the capacities of the ink tanks are determined in accordance with the predicted volume of use of each ink; therefore, it is possible to prevent any ink tank from becoming empty earlier than others even when a plurality of ink tanks are combined to form the ink cartridge.

[0018]

[Embodiments]

Embodiments of the present invention will now be described with reference to the drawings. Fig. 1 is a block diagram for showing the configuration of an ink-jet recording apparatus according to a first embodiment of the present invention.

[0019]

In Fig. 1, 1 denotes an image input unit which optically reads an original image by CCD or the like, or receives an image luminance signal (RGB) from a host computer or video equipment, and 2 denotes a control unit provided with various keys for setting diverse parameters and instructing print start. A reference numeral 3 indicates a CPU which controls the whole recording apparatus in accordance with various programs in a ROM. A reference numeral 4 indicates a ROM which stores primarily the program for operating the recording apparatus in accordance with a control program and an error processing program. In this ROM 4, 4a indicates an input gamma conversion table, which is referred to for the processing in an input gamma conversion circuit, 4b indicates a masking coefficient, which is referred to for the processing in a color correction (masking) circuit, 4c indicates a black generating and UCR table, which is referred to for generating black and the processing in a UCR circuit, 4 indicates a dark/light distribution table, which is referred to for the processing

in the dark/light distribution circuit to be discussed later, and 44e indicates a program group which stores the diverse programs mentioned above. A reference numeral 5 denotes a RAM which is used as a work area of various programs in the ROM and as a temporary save area for processing an error. Further, 6 denotes a processing unit which performs the image signal processing to be discussed later, and 7 denotes the printer unit which forms a dot image in accordance with the image signal which has been processed by the image signal processing unit during recording. A reference numeral 8 shows a bus line which transmits address signals, data, control signals, etc. in the apparatus. The image signal processing unit will now be described.

[0020]

Next, description will be made on the image signal processing system 6, with reference to Fig. 2. An input gamma correction circuit 11 receives a red image luminance signal R, a green image luminance signal G, and a blue image luminance signal B, and converts the received signals into a cyan image density signal 21C, a magenta image density signal 21M, and a yellow image density signal 21Y.

[0021]

The signals undergo the color processing performed by a color correction (masking) circuit 12 and a black formation and UCR (undercolor removal) circuit 13 to be further converted to new cyan, magenta, yellow, and black image density signals, 23C, 23M, 23Y, and 23K. The cyan,

magenta, yellow, and black image density signals 24C, 24M, 24Y, and 24K, which have undergone the gamma correction through an output gamma correction circuit 14 further go through a dark/light distribution circuit 15 to be divided into image density signals 25Ck, 25Mk, 25Yk, and 25Kk of the dark cyan, dark magenta, dark yellow, and dark black with high dye densities, respectively, and image density signals 25Cu, 25Mu, 25Yu, and 25Ku of the light cyan, light magenta, light yellow, and light black with low dye density, respectively.

[0022]

Fig. 3 shows the examples of the dark/light distribution table. In Fig. 3, (a) shows the table which is used when the standard binary recording is performed by using inks of a single density. When the inks of two different densities, dark and light, are used, the conversion table in (b) of Fig. 3.

[0023]

This table is set so that the image density signal values and the optical reflection density values of a recorded image show a relationship of proportional line. The dark and light signals are produced by the dark/light distribution circuit according to the dark/light distribution table. All the image density signals, which have been divided into the dark and light signals, are binarized in the binarizing circuit to cause the inks to be discharged from the corresponding ink discharge port

trains of the respective ink-jet units in accordance with the signal values, thereby forming a color image. In the case of the table shown in (b) of Fig. 3, the thin inks are used over all gradation areas of the image from the highlighted area to the dark area, while the dark ink is used only from the medium-tone area to the dark area.

[0024]

The printer unit of this embodiment will now be described with reference to Fig. 4. An ink-jet unit 40 comprises an ink-jet unit 40u for a thin ink and an ink-jet unit 40k for a thick ink, the two ink-jet units being mounted on the carriage 41 with a specified distance between them. The ink-jet unit 40u for a thin ink has a discharge port train for discharging a thin black ink, a discharge port train for discharging a thin cyan ink, a discharge port train for discharging a thin magenta ink, and a discharge port train for discharging a thin yellow ink. The ink-jet unit 40k for a thick ink has a discharge port train for discharging a thick black ink, a discharge port train for discharging a thick cyan ink, a discharge port train for discharging a thick magenta ink, and a discharge port train for discharging a thick yellow ink.

[0025]

The inks for corresponding nozzle trains of ink-jet units 40 are supplied from ink cartridges 48. The ink cartridges are grouped by the same color family; 48Y is the ink cartridge which supplies the inks of dark yellow and

light yellow, 48M is the ink cartridge which supplies the inks of dark magenta and light magenta, 48C is the ink cartridge which supplies the inks of dark cyan and light cyan, and 48K is the ink cartridge which supplies the inks of dark black and light black.

[0026]

A control signal, or the like, is sent to the ink-jet unit 40 a flexible cable 49. A material to be recorded on P consisting of paper, a plastic thin plate or the like is held by delivery rollers 42 via delivery roller (not shown), and it is fed in the direction of the arrow as a delivery motor, which is not shown, is driven. A guide shaft 43 and an encoder (not shown) guide and support the carriage 41. The carriage 41 is shuttled along the guide shaft 43 mentioned above by a carriage motor 45 via a drive belt 44.

[0027]

Provided inside (liquid passage) of the ink discharge ports of the ink-jet unit 40 are a heat generating device (electrothermal energy transducer) which generates heat energy for discharge the ink. An image can be formed by driving the heat generating device in accordance with a recording signal and the reading timing of the encoder (not shown), and by jetting and depositing the ink droplets onto the material to be recorded on in the sequence of the thick ink color and the thin ink color.

[0028]

A restoring unit, which has a cap unit 47, is

disposed in the home position of the carriage 41, the home position being selected outside the recording area. When recording is not performed, the carriage 41 is moved to the home position and the ink discharge port surface of the corresponding recording head is tightly sealed by a cap of the cap unit 47, thus preventing clogging caused by adhering ink due to an evaporated ink solvent or by adhering foreign matters such as dust.

[0029]

Further, to prevent defective discharge or clogging of the ink discharge ports, which are less frequently used, the capping function of the cap section 47 is used for an idle discharge mode, wherein the ink is discharged to the cap unit 26 away from the ink discharge ports, or for restoring the discharge of an ink discharge port, which has developed a discharge failure, by operating a pump, which is not illustrated, with the cap closed in order to suction the ink from the ink discharge port. Furthermore, the ink discharge port surface can be cleaned by disposing a blade or wiping component near the cap unit.

[0030]

Description will be made on the configuration of an ink-jet unit which is used in this embodiment with reference to Fig. 5. One end of a wiring board 50 is interconnected with a wiring section of a heater board 51, and the other end of the wiring board 50 is provided with a plurality of pads, which correspond to the electrothermal

energy converters for receiving electrical signals from the apparatus. This allows the electrical signals from the apparatus to be supplied to the respective electrothermal energy converters.

[0031]

A metallic support 52, which supports the rear surface of the wiring board 50 by the flat surface thereof, provides the bottom plate of an ink-jet unit. A holding spring 53 has a section, which is bent so that the cross-section thereof is approximately U-shaped to linearly and elastically apply a pushing force to the area near the ink discharge port of a groove top 54, hooks 53a, which hook themselves by utilizing the relief holes 59a provided in a base plate, and a pair of rear legs 53b which receive the force acting on the spring on the base plate. The spring force presses the wiring board 200 in contact with the groove top 1300. The spring force presses the wiring board 50 in contact with the groove top 54. The wiring board 50 is mounted on the support 52 by adhesion using an adhesive agent or the like.

[0032]

As shown in Fig. 5, there are provided four ink supply pipes 55 for yellow, magenta, cyan, and black in this embodiment. The end of each ink supply pipe 55 is provided with a filter 56. An ink supply member 57 is produced by molding, the groove top having channel leading to the ink supply ports, which are made into one piece. The ink supply

member 57 can be easily fixed to the support 52 by passing two pins (not shown) on the rear surface of the ink supply member 57 into holes 59 of the support 52 and jutting them, then thermally fusing them.

[0033]

At this time, the clearance between the orifice plate section 58 and the ink supply member 57 is evenly formed. A sealant is poured through a top sealant pouring port of the ink supply member 57 to seal the wire bonding and also seal the clearance between the orifice plate section 58 and the ink supply member 57, further pass through a groove 501, which is provided in a support base 52, then completely seal the clearance between the orifice plate section 58 and the front end of the support base 52.

[0034]

Fig. 6 is the enlarged perspective view of the groove top 54, which is shown in Fig. 5, observed from the heater board 51 side. In this embodiment, there are provided four liquid chambers for the yellow ink, magenta ink, cyan ink, and black ink, respectively, the liquid chambers being partitioned by walls 60a through 60c. The respective liquid chambers are provided with supply ports 61a through 61d for supplying the inks.

[0035]

There are provided grooves 62a through 62c at the pressure-contacted surface between the groove top and the heater board 51 of the walls 60a through 60c partitioning

the liquid chambers. The grooves are communicated with the outer peripheral section of the groove top 54. After the groove top 54 is pressure-contacted to bring it into close contact with the heater board, the outer peripheral section is sealed with the sealant as previously described. At this time, the sealant moves along the aforesaid grooves to fill the clearance between the groove top and the heater board. Thus, the technical process used for the conventional head can be used to completely separate the liquid chambers. The structure of the grooves differs according to the physical property of the sealant, and it needs to be designed to match each physical property. Thus, different inks can be supplied from the respective ink discharge ports by separating the liquid chamber into a plurality of chambers.
[0036]

Referring to Fig. 7, the configuration of the ink discharge port trains and an example of forming an image will be described. Fig. 7 is a view of the ink discharge port trains of the ink-jet units observed from the side of the material to be recorded on; two ink-jet units are used for the thick inks and the thin inks, respectively, each ink-jet unit having the ink discharge port trains for yellow, magenta, cyan, and black, respectively.
[0037]

In an ink-jet unit 70k,70Yk is the discharge port train for discharging the thick yellow ink, 70Mk is the discharge port train for discharging the thick magenta ink,

70Ck is the discharge port train for discharging the thick cyan ink, and 70Kk is the discharge port train for discharging the thick black ink. In an ink-jet unit 71u, 71Yu is the discharge port train for discharging the thin yellow ink, 71Mu is the discharge port train for discharging the thin magenta ink, 71Cu is the discharge port train for discharging the thin cyan ink, and 71Ku is the discharge port train for discharging the thin black ink. Each discharge port train has 32 discharge ports with a pitch of 360 dots per inch (360 dpi), 8-dot blanks being provided between the respective colors by the walls of the liquid chambers.

[0038]

Fig. 8 is the diagram which shows the image forming process in this embodiment. The explanation of the diagram is based on an assumption that there is no blank between colors. Referring to the Nth + 1 line, the recording with the dark black and the thin black in the first scan S1, then the material to be recorded on is carried in the sub-scan direction by a predetermined amount (line feed; hereinafter referred to as "LF"). In the second scan S2, the recording with the dark cyan and the light cyan and LF are carried out; in the third scan S3, the recording with the thick magenta and the thin magenta and LF are carried out; and in the fourth scan S4, the recording with the thick yellow and the thin yellow and LF are carried out, thus completing the image of the Nth + 1 line. The LF amount after the scan

recordings is equivalent to a 32-dot width, and the image of the 32-dot width is recorded by the four scan recordings. In Fig. 8, the fifth scan was performed, completing an image of the Nth + 2 lines.

[0039]

The recording process of the configuration example described above does not record all colors at a time, permitting the formation of a good image with minimized image deterioration caused primarily by bleeding. In an actual ink-jet unit, there are blanks between colors; therefore, the connecting positions of the recording scans of the respective colors do not coincide from one color to another as in the explanation of the diagram, the differences in position lead to such an effect that controls the occurrence of the connecting lines of the recording scans.

[0040]

The use of the ink-jet units, which have divided liquid chambers and which are provided with the ink discharge ports discharging the inks of different colors, the discharge ports being formed in the same surface, makes it possible to reduce the number of the ink-jet units (recording heads) and the number of the ink cartridges, enabling a smaller apparatus. In addition, the ink-jet units used for this embodiment permit accurate and inexpensive formation of the discharge port trains for different colors in the same discharge surface; therefore,

the high level of apparatus accuracy or the complicated correction control as in the conventional apparatus is no longer required, thus permitting a lower price.

[0041]

The ink-jet units of this embodiment preferably have all the color discharge port trains arranged on the same straight line to reduce the correction of the ink discharge timings, however, they are not limited to this embodiment; the color discharge port trains may be arranged horizontally or arranged zigzag. Furthermore, the recording speed can be increased by changing the number of the discharge ports for each color as necessary.

[0042]

Referring to Fig. 9, the principle-based configuration of the ink cartridges used for this embodiment will be explained. The ink of a compressed ink absorber 92 is maintained at a height, whereat the water head pressure of the ink discharge port section of the ink-jet unit, the pressure reduction in an ink chamber 91, and the capillary tube force of the compressed ink absorber 92 are balanced. When the ink is supplied from an ink supply section 93, the volume of the ink in an ink chamber 90 does not decrease, but an ink 94 of the ink chamber 91 is consumed. More specifically, the ink distribution in the ink chamber 90 remains unchanged, and with the balanced inner pressure maintained, the volume of the ink for the supply is dispensed from the ink chamber 91 for consumption, and the air

equivalent to that volume of ink is introduced from an air communicating section 95 via the ink chamber 90. At this time, the ink and the air are exchanged at the bottom end of the ink chamber wall as shown at the bottom center of Fig. 9, and the meniscus, which has been formed in the compressed ink absorber 92 of the ink chamber 90, is partially damaged in the area near the ink chamber 91, causing the air to be introduced into the ink chamber 91 so that the pressure of the ink chamber 91 is balanced mainly with the meniscus holding force of the compressed ink absorber 92.

[0043]

More detailed explanation will be given about the ink supply in the ink cartridges and the principle of the generation of the negative pressure in the ink of the method used for this embodiment, the method employing the absorber to divide the ink chamber. The compressed ink absorber 92 near the ink chamber wall 96 is communicated with the air communicating section 95 under a condition where a predetermined volume of the ink in the ink chamber 90 has been consumed; therefore, it has a meniscus formed against the atmospheric pressure. In other words, the negative pressure in the ink of the ink supply section 93 is maintained by the compressed ink absorber 92 near the ink chamber wall 96, which has been compressed and adjusted to a predetermined capillary tube force. The closed space at the top of the ink chamber 91 before the ink flows out is balanced

with the capillary tube force of the compressed ink absorber 92 near the ink chamber wall 96 and the water head pressure of the ink remaining in the ink chamber 91, and the pressure thereof is reduced to maintain the meniscus formed by the compressed ink absorber 92. From this condition, when the ink is supplied to the ink-jet unit via the ink supply section 93, the ink flows out of the ink chamber 91, and the pressure of the ink chamber 91 is further reduced by the volume of the ink which has been consumed. At this time, the meniscus formed in the compressed ink absorber 92 at the bottom end of the ink chamber wall 96 is partially damaged, causing the air to be introduced into the ink chamber, with the ink thereof being consumed, in order to balance with the water head pressure of the ink itself in the ink chamber 91 with the pressure thereof having been excessively reduced. In other words, the inner negative pressure of the ink supply section 93 is maintained at a specified value by the capillary tube force of the compressed ink absorber 92 close to the bottom end of the ink chamber wall 96.

[0044]

Fig. 10 is the perspective view which shows the structure of the ink cartridge used for this embodiment of the present invention. The ink cartridge is divided by partitioning walls, an ink chamber 91k holding the dark ink, and an ink chamber 91u holding the light ink. The same principle as the one described above applies to the supply of the inks from the ink chambers 91k and 91u to a supply

section 93k for the dark ink and a supply section 93u for the light ink.

[0045]

Fig. 11 is the perspective view which shows a variation of the ink cartridge used for this embodiment. The ink cartridge is divided by partitioning walls, an ink chamber101k holding the dark ink, and an ink chamber101u holding the light ink. The same principle as the one described above applies to the supply of the inks to a supply section 103k for the dark ink and a supply section 103u for the light ink. In the configuration of Fig. 11, the holding capacities for the dark ink and the light ink are different, the capacity for the thin ink being greater. Referring to the dark/light distribution table in (b) of Fig. 3, the light ink is consumed for all the gradation areas of the image from the highlighted area to the dark area, while the dark ink is consumed only for the medium tone area to the dark area of the image. Hence, more light ink is likely to be consumed in recording the image. The ink cartridge of the configuration shown in Fig. 11 is capable of preventing just one ink from running out extremely quickly by making the capacity for the thin ink larger than that for the thick ink, thus making it possible to efficiently use up the ink in the ink cartridge without waste.

[0046]

The ink cartridge described in this embodiment can be used primarily for a recording apparatus wherein an

ink-jet unit for each ink density is prepared; it can be applied also to a case, where the inks of three different densities, namely, dark, medium, and light, or the inks of more than three different densities are used, in addition to the embodiment which uses two different densities, namely, dark and light, by increasing the number of the partitioning walls in the ink cartridge according to the number of the types of ink.

[0047]

Further, the principle of holding the ink of the ink cartridge and supplying the ink is not limited to the contents of the description given above; an ink bag may be used or the whole ink chamber may be filled with a porous ink absorber to hold the ink.

[0048]

Furthermore, the ink cartridge of this embodiment is mounted on the carriage just like the ink-jet unit, but the ink may be supplied to the ink-jet unit via an ink supply tube without mounting the ink cartridge on the carriage.

[0049]

According to this embodiment, the number of the ink cartridges, which supply the inks to the ink discharge means, can be reduced to a minimum and the operability can be improved. Especially in a color ink-jet recording apparatus, the ink cartridges of the colors of the same group are made integral and therefore, only the ink cartridge of a color ink, which has run out, may be replaced, eliminating

the waste of throwing the inks, which are used less frequently, thus providing more advantages than the case wherein the cartridges of all colors are made into one piece.

[0050]

(Second Embodiment)

Description will be made on the configuration of an essential portion of a color ink-jet recording apparatus according to a second embodiment of the present invention with reference to Fig. 12. In this embodiment, there are provided in the carriage 111 at predetermined intervals a black ink-jet unit 110K having a discharge port train for discharging dark black ink and a discharge port train for discharging light black ink, a cyan ink-jet unit 110C having a discharge port train for discharging dark cyan ink and a discharge port train for discharging light cyan ink, a magenta ink-jet unit 110M having a discharge port train for discharging dark magenta ink and a discharge port train for discharging light magenta ink, and a yellow ink-jet unit 110Y having a discharge port train for discharging dark yellow ink and a discharge port train for discharging light yellow ink.

[0051]

The inks are supplied from the ink cartridges 118 (118K, 118C, 118M and 118Y) to the nozzle trains corresponding to the respective ink-jet units 110 (110K, 110C, 110M and 110Y). The ink cartridges are collected for each color group. The yellow ink cartridge 118Y is a

cartridge for supplying inks of dark and light yellow colors to the yellow ink-jet unit 110Y, the ink magenta cartridge 118M is a cartridge for supplying inks of dark and light magenta colors to the magenta ink-jet unit 110M, the cyan ink cartridge 118C is a cartridge for supplying inks of dark and light cyan colors to the cyan ink-jet unit 110C, and the black ink cartridge 118K is a cartridge for supplying inks of dark and light black colors to the black ink-jet unit 110K. In addition, a control signal, or the like, is transmitted to the ink jet units 110 through the flexible cable 119.

[0052]

The recording medium made of paper or a plastic thin plate is sent, via a deliver roller (not shown), to be sandwiched by and between an exhaust roller 112 in the direction indicated by the arrow, upon driving of an unrepresented convey motor. The carriage 111 is guided by a guide shaft 113 and supported by an encoder (not shown). The carriage 111 is moved back and forth along the guide shaft 43 upon driving the carriage motor 115 through a drive belt.

[0053]

Inside the ink discharge port of the ink-jet units 110 (liquid paths), there are provided heat generating elements (electrothermal energy converters) for generating heat energy for discharging inks. In accordance with reading timings of the encoder, the heat generating elements

are driven in response to recording signals, and ink liquid drops are flied and applied on the recording medium in the order from the dark ink color and the light ink color, so as to form an image. In accordance with reading timings of the encoder, the heat generating elements are driven in response to recording signals, and ink liquid drops are flied and applied on the recording medium in the order from the dark and light black inks, the dark and light cyan inks, dark and light magenta inks, and the dark and light yellow inks, so as to form an image. At the home position of the carriage which is selected to be outside the recording area, a restoring unit 116 having a cap unit 117 is disposed to secure the stability of ink discharging.

[0054]

The configuration of the ink-jet unit used in the present embodiment will be described with reference to Fig. 13. One end of a wiring board 120 is interconnected with a wiring section of a heater board 121 and the other end of the wiring board 120 is provided with a plurality of pads, which correspond to the electrothermal energy converters for receiving electrical signals from the apparatus. This allows the electrical signals from the apparatus to be supplied to the respective electrothermal energy converters.

[0055]

A metallic support 122, which supports the rear surface of the wiring board 120 by the flat surface thereof,

provides the bottom plate of an ink-jet unit. A holding spring 123 has a section, which is bent so that the cross-section thereof is approximately U-shaped to linearly and elastically apply a pushing force to the area near the ink discharge port of a groove top 124, hooks 123a, which hook themselves by utilizing the relief holes 129a provided in a base plate, and a pair of rear legs 123b which receive the force acting on the spring on the base plate. The spring force presses the wiring board 120 in contact with the groove top 124. The wiring board 120 is mounted on the support by adhesion using an adhesive agent or the like.

[0056]

There are provided two ink supply pipes 55 corresponding to the dark inks and the light inks. The ends of ink supply pipes 125 are provided with filters 126. An ink supply member 127 is produced by molding, the groove top having channel leading to the ink supply ports. The ink supply member 127 can be easily fixed to the support 122 by passing two pins (not shown) on the rear surface of the ink supply member 127 into holes 129 of the support 122 and jutting them, then thermally fusing them. At this time, the clearance between the orifice plate section 128 and the chip tank 127 is evenly formed. A sealant is poured through a top sealant pouring port of the chip tank 127 to seal the wire bonding and also seal the clearance between the orifice plate section 128 and the chip tank 127, further pass through a groove 120, which is provided in a support base 122, then

completely seal the clearance between the orifice plate section 128 and the front end of the support base 122.

[0057]

Fig. 14 is the perspective view of the groove top 124 of the recording head unit used in this embodiment, the groove top 124 being observed from the heater board 121 side. Two of liquid chambers are provided for the dark ink and the light ink, each liquid chamber being partitioned by a wall 130. Each liquid chamber has supply ports 131a and 131b through which the inks are supplied. There is provided a groove 132 at the pressure-contacted surface between the groove top and the heater board 121 of the wall 130 partitioning the liquid chambers. The groove is communicated with the outer peripheral section of the groove top 124. After the groove top 124 is pressure-contacted to bring it into close contact with the heater board, the outer peripheral section is sealed with the sealant as previously described. At this time, the sealant moves along the aforesaid groove to fill the clearance between the groove top and the heater board. Thus, the technical process used for the conventional head can be used to completely separate the liquid chambers. The structure of the groove differs according to the physical property of the sealant, and it needs to be designed to match each physical property. Thus, separating a single liquid chamber into a plurality of chambers makes it possible to supply different inks through the respective ink discharge ports.

[0058]

The configuration of the ink discharge port trains and an example of forming an image will now be explained with reference to Fig. 15 and Fig. 16. Fig. 15 is a view of the ink discharge port trains of the ink-jet units observed from the side of the material to be recorded on; a single ink-jet unit has the ink discharge port trains for the thick inks and the thin inks, respectively; and the ink-jet units for yellow, magenta, cyan, and black inks are used.

[0059]

The ink-jet unit 143 includes an ink-jet unit 143 for discharging an ink of yellow color, an ink-jet unit 142 for discharging an ink of magenta color, an ink-jet unit 141 for discharging an ink of cyan color, and an ink-jet unit 140 for discharging an ink of black color. Reference numerals 143Yu, 142Mu, 141Cu and 140Ku respectively denote discharge port trains for discharging light inks, while reference numerals 143Yk 142Mk, 141Ck and 140Kk respectively denote discharge port trains for discharging dark inks. Each discharge port train has 64 discharge ports with a pitch of 360 dots per inch (360 dpi), 8-dot blanks being provided between the dark-ink discharge port trains and the light-ink discharge port trains by the walls of the liquid chambers.

[0060]

Fig. 16 is the diagram which shows the image forming

process in this embodiment. The explanation of the diagram is based on an assumption that there is no blank between colors. Referring to the Nth + 1 line, the recording with the dark black, dark cyan, dark magenta, and dark yellow and LF are carried out in the first scan, then the recording with the light black, light cyan, light magenta, and light yellow and LF are carried out in the second scan, thus completing the image by the two scan recordings. The LF amount after the scan recordings is equivalent to a 64-dot width, and the image of the 64-dot width is recorded by the two scan recordings.

[0061]

In this configuration, as in the previous embodiment, the recording process does not record all colors at a time; therefore, a good image with minimized image deterioration caused primarily by bleeding can be obtained. Furthermore, in an actual ink-jet unit, there are blanks between colors; therefore, the connecting positions of the recording scans of the respective colors do not coincide from one color to another as in the explanation of the diagram, the differences in position lead to such an effect that controls the occurrence of the connecting lines of the recording scans.

[0062]

In addition, according to the configuration explained in this embodiment, the color blending, which is apt to take place during the discharge restoring operation,

can be also effectively controlled. In particular, the ink color blending caused by ink rundown following the suction during the discharge restoring operation can be prevented by placing the discharge port trains of the inks with the low density (light inks) at the upper side and the inks with the high density (dark inks) at the lower side.

[0063]

Like the previous embodiments, this embodiment also divides the liquid chamber and uses ink-jet units provided with ink discharge ports for discharging the inks of different colors, the discharge ports being formed in the same surface, thus making it possible to reduce the number of the ink-jet units (recording heads) and the number of the ink cartridges, consequently enabling a smaller apparatus. In addition, the ink-jet units used for this embodiment permit accurate and inexpensive formation of the discharge port trains for different colors in the same discharge surface; therefore, the high level of apparatus accuracy or the complicated correction control as in the conventional apparatus is no longer required, thus permitting a lower price.

[0064]

The ink-jet units of this embodiment preferably have all the color discharge port trains arranged on the same straight line to reduce the correction of the ink discharge timings, however, they are not limited to this embodiment; the color discharge port trains may be arranged

horizontally or arranged zigzag.

[0065]

Furthermore, as it was explained in this embodiment, the recording speed can be increased by changing the number of the discharge ports for each color as necessary.

[0066]

Fig. 17 is the configuration diagram which shows the major section of the ink cartridge used for this embodiment of the present invention. The ink cartridge is divided by partitioning walls, the ink chamber 161k holding the dark ink, and the ink chamber 161u holding the light ink. The same principle as the one described above applies to the supply of the inks to the supply section 163k for the dark ink and the supply section 163u for the light ink.

[0067]

Fig. 18 is the configuration diagram which shows the major section of another ink cartridge used for the embodiment of the present invention. The ink cartridge is divided with partitioning walls, the ink chamber 171k holding the dark inks and the ink chamber 171u holding the light inks. The inks are supplied to the dark ink supply section 173k and the light ink supply section 173u according to the principle discussed previously. In the configuration of Fig. 18, the holding capacities for the dark ink and the light ink are different. Referring to the dark/light distribution table in(b) of Fig. 3, the light ink is consumed for all the gradation areas of the image

from the highlighted area to the dark area, while the dark ink is consumed only for the medium tone area to the dark area of the image. Hence, more light ink is likely to be consumed in recording the image. The ink cartridge of the configuration shown in Fig. 18 makes it possible to efficiently use up the ink in the ink cartridge without waste by making the capacity for the thin ink larger than that for the thick ink.

[0068]

The ink cartridge described in this embodiment can be applied also to a case, where the inks of three different densities, namely, dark, medium, and light, or the inks of more than three different densities are used, in addition to the embodiment which uses two different densities, namely, dark and light, by increasing the number of the partitioning walls in the ink cartridge according to the number of the types of ink.

[0069]

Further, the principle of holding the ink of the ink cartridge and supplying the ink is not limited to the description given above; an ink bag may be used or the whole ink chamber may be filled with a porous ink absorber to hold the ink. Furthermore, the ink cartridges of this embodiment are mounted on the carriage together with the ink-jet units, but the inks may be supplied to the ink-jet unit via ink supply tubes without mounting the ink cartridges on the carriage.

[0070]

According to this embodiment, the number of the ink cartridges, which supply the inks to the ink discharge means, can be reduced to a minimum and the operability can be improved. Especially in a color ink-jet recording apparatus, the ink cartridges of the colors of the same group are made integral and therefore, only the ink cartridge of a color ink, which has run out, may be replaced, eliminating the waste of throwing the inks, which are used less frequently, thus providing more advantages than the case wherein the cartridges of all colors are made into one piece.

[0071]

(Third Embodiment)

The third embodiment of the present invention will now be described. Fig. 19 shows the configuration of the integral ink-jet cartridge wherein an ink-jet units 224 of the four colors, namely, yellow, magenta, cyan, and black, are assembled into one piece by a frame 220. The ink-jet units 224 have the discharge port trains for discharging the dark inks and the discharge port trains for discharging the light inks. The configuration of the ink-jet units 224 has already been explained in detail in the previous configuration example; therefore, the explanation thereof will be omitted.

[0072]

The four ink-jet units 224 are provided inside the frame 220 at predetermined intervals, and are fixed with

a registration adjusted in the direction of the nozzle trains. Reference numeral 221 denotes the cover of the frame, and 222 a connector for connecting electric signals from the pads provided on the wiring boards 120 of the four ink-jet units 224 and the main apparatus. The wiring board 120 and the connector 222 are coupled to each other by the electrode 223.

[0073]

Fig. 20 shows an integral ink-jet cartridge, the cartridge having been mounted on the carriage. The ink holding and supplying principle is the same as that explained in the previous embodiment.

[0074]

The ink cartridge 118 is divided into two chambers, top and bottom, with a partitioner 230, the top chamber being filled with the thin ink and the bottom chamber being filled with the thick ink. On the carriage, the ink-jet cartridge 222 are the four ink cartridges 118 for the yellow, magenta, cyan, and block inks are connected by pressure-contact, and the inks are supplied from the ink cartridges 118 to the corresponding ink discharge port trains.

[0075]

As in the previous embodiments, in this configuration, the recording process does not record all colors at a time; therefore, a good image with minimized image deterioration caused primarily by bleeding can be obtained. Furthermore, in an actual ink-jet unit, there are

blanks between colors; therefore, the connecting positions of the recording scans of the respective colors do not coincide from one color to another as in the explanation of the diagram, the differences in position lead to such an effect that controls the occurrence of the connecting lines of the recording scans.

[0076]

The integral ink-jet cartridge can be assembled to be an integral cartridge, wherein the ink-jet units, which have a plurality of ink discharge port trains in the same discharge port surface, are accurately arranged. This solves the problem of the registration discrepancy between the ink-jet units, leading to reduced correction control load. In addition, the electrical contacts of the ink-jet units can be shared, enabling a reduction in the number of the contacts to the apparatus main body.

[0077]

The ink-jet units of this embodiment preferably have all the color discharge port trains arranged on the same straight line to reduce the correction of the ink discharge timings, however, they are not limited to this embodiment; the color discharge port trains may be arranged horizontally or arranged zigzag. Furthermore, the recording speed can be increased by changing the number of the discharge ports for each color as necessary.

[0078]

Further, the ink cartridges are preferably mounted

on the carriage just like the ink-jet cartridges, but it may be made integral with the ink-jet cartridges or the inks may be supplied to the ink-jet cartridges via an ink supply tubes without mounting the ink cartridges on the carriage.
[0079]

Like the previous embodiments, this embodiment also permits a reduced size of the apparatus and also eliminates the need of the high level of apparatus accuracy of complicated correction control, enabling a lower price. Furthermore, the number of the ink cartridges supplying the inks to the ink discharge means can be reduced to a minimum, allowing improved operability.
[0080]

The present invention brings outstanding effects especially in the ink-jet type recording heads and recording apparatuses which are designed to form flying droplets by utilizing heat energy to perform recording, among the ink-jet recording type recording heads or recording apparatuses.
[0081]

The preferable typical configurations and principles are the ones which employ the basic principle disclosed, for example, in the specification of US Patent No. 4723129 and the specification of US Patent No. 4740796. The method can be applied to both "on-demand type" and "continuous type"; the on-demand type, in particular, is effective because by applying at least one drive signal,

which corresponds to recording information and causes a quick temperature rise exceeding nuclear boiling point, to an electrothermal converter, which is disposed corresponding to a seat or liquid passage holding a liquid (ink), to generate heat energy in the electrothermal converter, thereby to cause the film boiling on the heat working surface of the recording head, consequently forming a ~~foam~~ bubble in the liquid (ink), which exactly corresponds to the drive signal. The liquid (ink) is discharged through a discharge aperture by the growth, expansion and contraction of the ~~foam~~ bubble, thereby forming at least one droplet. More preferably, the drive signal is formed into a pulse so that the ~~foam~~ bubble will immediately and properly grow, expand and contract, achieving the discharge of the liquid (ink) featuring especially excellent responsiveness.

[0082]

As the pulse-shaped drive signal, the ones disclosed in the specification of US Patent No. 4463359 and the specification of US Patent No. 4345262 are suited. Further, even better recording can be accomplished by adopting the conditions described in the specification of the invention under US Patent No. 4313124, which are related to the temperature rising rate of the aforesaid heat working surface.

[0083]

As the configuration of the recording head, a configuration, wherein the heat working section is disposed

in a bent area, may be alternatively used, the configuration being disclosed in the specification of US Patent No. 4558333 and the specification of US Patent No. 4459600 in place of the configuration combining the discharge ports, liquid passages, and electrothermal converters (linear liquid passages or right-angle liquid passages) as disclosed in the specifications mentioned above.

[0084]

As still another alternative configuration, the configuration based on the publication of unexamined JP patent application No. 59-123670 which discloses a configuration, wherein a common slit provides the discharge section of the electrothermal converter, or the configuration based on the publication of unexamined JP patent application No. 59-138461, wherein the aperture absorbing the pressure wave of heat energy is made relevant to the discharge section may be used.

[0085]

Further, as the full-line type recording head, which has a length corresponding to the width of the maximum recording medium on which the recording apparatus can record, either the configuration, wherein the length is satisfied by combining a plurality of recording heads as disclosed in the specifications mentioned above, or the configuration characterized by a single recording head formed as one piece may be used.

[0086]

Still further, a replaceable chip type recording head, which permits electrical connection with the apparatus main body and the supply of the inks from the apparatus main body when it is mounted on the apparatus main body, or a cartridge type recording head, wherein ink tanks are provided integrally with the recording head itself, may be used.

[0087]

Adding a restoring means for the recording head, standby auxiliary means, etc. to the recording apparatus of the present invention is preferable because it adds to stable effects of the present invention. To be more specific, such preferable addition, which is effective for ensuring stable recording, includes a capping means for the recording head, a cleaning means, a pressurizing or suction means, a standby heating means consisting of an electrothermal converter or a separate heating element or a combination of the former two, and the implementation of the standby discharge mode wherein discharge independent of recording is performed.

[0088]

Further, the recording mode is not limited to the main color mode such as the black mode. The present invention is effectively applied to an apparatus which has a single recording head integrally formed or a combination of plural recording heads, with a plurality of different colors or at least one of full colors mixed.

[0089]

In the embodiments of the present invention described above, the description was given using the inks as the liquids; the inks solidify at or below room temperature, and most inks soften or remain liquids at room temperature; or in the ink-jet method described above, the ink temperature is controlled so that the inks stay within a range of 30°C to 70°C to keep the viscosity of the inks within the stable discharge range; therefore, any inks are acceptable as long as they are liquids when the recording signal is applied.

[0090]

In addition, the rising temperature caused by the heat energy may be actively used as the energy for changing the state of the ink, that is, from the solid state to the liquid state; or an ink, which solidifies when it is let stand, may be used for the purpose of preventing the ink from evaporating; or an ink, which liquefies when heat energy is applied in response to the recording signal and which is discharged as a liquid ink; or an ink, which begins to solidify already at the point of reaching the recording medium; all those inks which liquefy only when heat energy is applied to the same, may be applied to the present invention. In such a case, the ink may be held as a liquid or solid material in a porous seat concave or a through hole, facing the electrothermal converter, as described in the publication of the unexamined JP No. 54-56847 or the

publication of the unexamined JP No. 60-71260. In the present invention, implementing the film boiling method mentioned above is most effective for the inks described above.

[0091]

Still further, the recording apparatus according to the present invention may take a form of a copying apparatus combined with a reader or the like, or a facsimile apparatus having a transmitting and receiving feature, in addition to the form wherein the recording apparatus is provided in the form of an image output terminal as a part of or independently of information processing equipment such as a word processor and computer as mentioned above.

[0092]

[Effect of the Invention]

As described above, according to the present invention, it is possible to provide a small, inexpensive apparatus which features excellent gradation and resolution and which is capable of producing an image with an extremely good graininess, to minimize the number of the ink cartridges for supplying ink to the ink discharge means, and to permit easier operation.

[Brief Description of the Drawings]

[Figure 1]

A block diagram which shows the configuration of a color ink-jet recording apparatus according to the first embodiment of the present invention.

[Figure 2]

A diagram which shows an example of an image signal processing circuit in the embodiment shown in Fig. 1.

[Figure 3]

Explanatory diagrams which shows an example of the dark/light distribution table of the embodiment shown in Fig. 1.

[Figure 4]

A perspective view which shows the configuration of the major section of a printing mechanism in the embodiment shown in Fig. 1.

[Figure 5]

A configuration diagram of the ink-jet unit in the embodiment shown in Fig. 1.

[Figure 6]

A configuration diagram of the head unit in the embodiment shown in Fig. 1.

[Figure 7]

A diagram which shows the layout of the trains of the ink discharge ports of the ink-jet unit.

[Figure 8]

An explanatory diagram which shows an image forming process in the embodiment shown in Fig. 1.

[Figure 9]

An explanatory diagram of the principle-based configuration of the ink cartridge used for the embodiment shown in Fig. 1.

[Figure 10]

A perspective view which show the configuration of the ink cartridge used for the embodiment shown in Fig. 1.

[Figure 11]

A perspective view which show the configuration of the ink cartridge used for the embodiment shown in Fig. 1.

[Figure 12]

A perspective view which show the configuration of a major section of the color ink-jet recording apparatus according to the second embodiment of the present invention.

[Figure 13]

A configuration diagram of the ink-jet unit in the embodiment shown in Fig. 12.

[Figure 14]

A configuration diagram of the head unit in the embodiment shown in Fig. 12.

[Figure 15]

A diagram which shows the layout when an ink-jet unit, which has the discharge port trains for dark ink and light ink in the same ink-jet unit, is used.

[Figure 16]

A diagram which illustrates the image forming process applied when the ink-jet unit of the ink discharge port trains shown in Fig. 15 is used.

[Figure 17]

A configuration diagram of the major section of the ink-jet cartridge used for the embodiment shown in Fig. 12.

[Figure 18]

A configuration diagram of the major section of the ink-jet cartridge used for the embodiment shown in Fig. 12.

[Figure 19]

A diagram which shows the configuration of an ink-jet cartridge integrally incorporating a plurality of ink-jet units according to the third embodiment of the present invention.

[Figure 20]

A diagram which shows a state in which the integrally formed ink-jet cartridge is mounted on the carriage in the embodiment shown in Fig. 19.

[Figure 21]

A perspective view which shows the configuration of the major section of a color ink-jet recording apparatus which employs the conventional dark and light inks.

[Description of Reference Numerals or Symbols]

1 ... image input unit

2 ... scan unit

3 ... CPU

4 ... ROM

4a ... input/output gamma conversion table

4b ... masking table

4c ... black generating and UCR table

4d ... dark/light distribution table

4e ... program group

5 ... RAM

6 … image signal processing unit

7 … printer unit

8 … bus line

11 … input gamma conversion circuit

12 … color correction (masking) circuit

13 … black generating and UCR circuit

14 … output gamma conversion circuit

15 … dark/light distribution processing circuit

16 … binarizing process circuit

40, 110, 240 … ink-jet units

41, 111, 241 … carriages

42, 112, 242 … exhaust rollers

43, 113, 243 … guide shafts

44, 114, 244 … drive belts

45, 115, 245 … carriage motors

46, 116, 246 … restoring units

47, 117, 247 … cap units

48, 118, 248 … ink cartridges

50, 120 … wiring boards

51, 121 … heater boards

52, 122 … supports

53, 123 … holding springs

54, 124 … groove tops

55, 125 … ink supply pipes

56, 126 … filters

57, 127 … ink supply members

58, 128 … orifice plates

59, 129 … fitting holes

60, 130 … partitioning walls

61, 131 … ink supply ports

62, 132 … grooves

90, 91 … ink chambers

92 … compressed ink absorber

93 … ink support section

94 … ink

95 … air communicating section

96 … ink chamber wall

220 … frame

222 … connector

223 … electrode

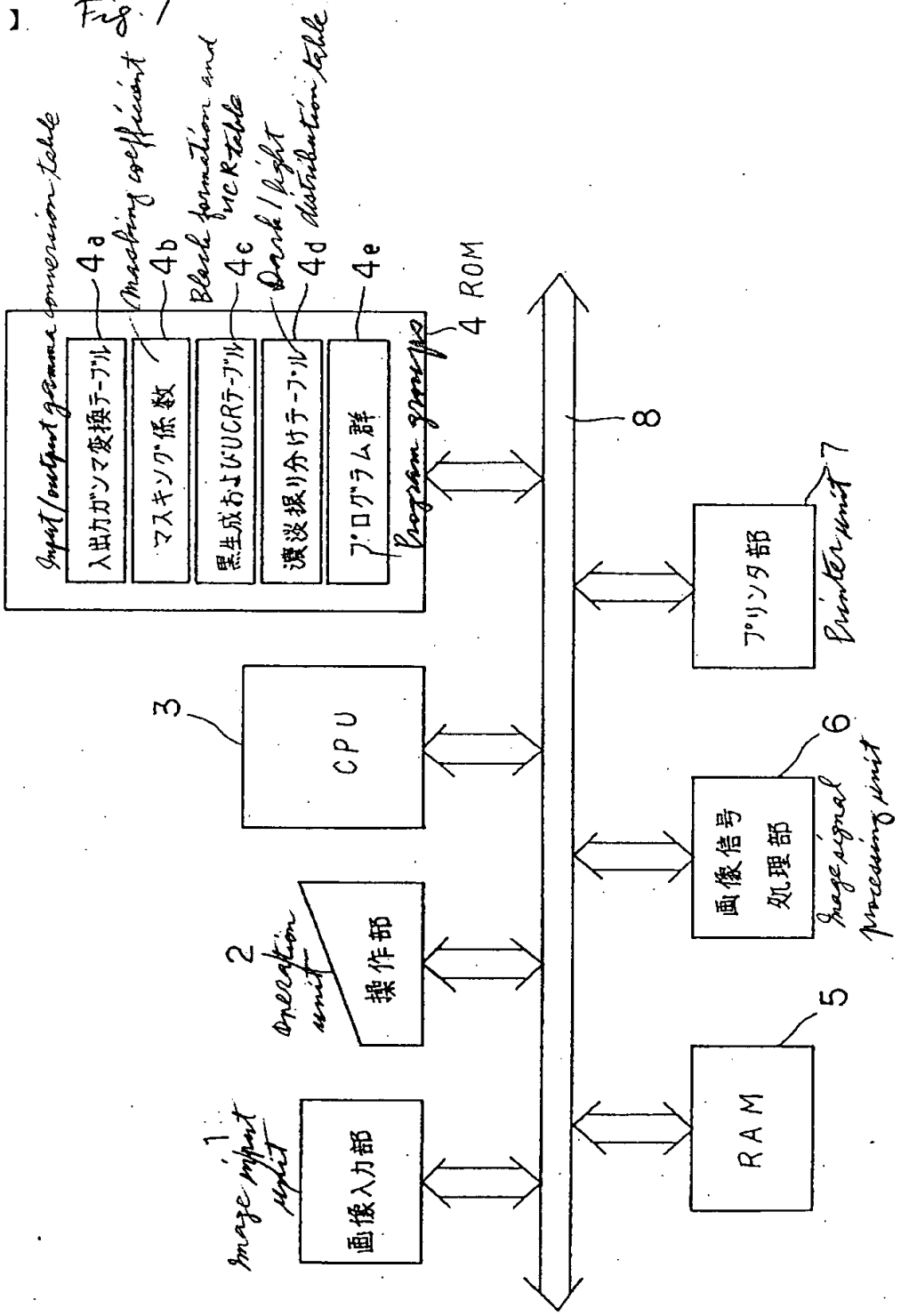
224 … ink-jet unit

230 … ink cartridge

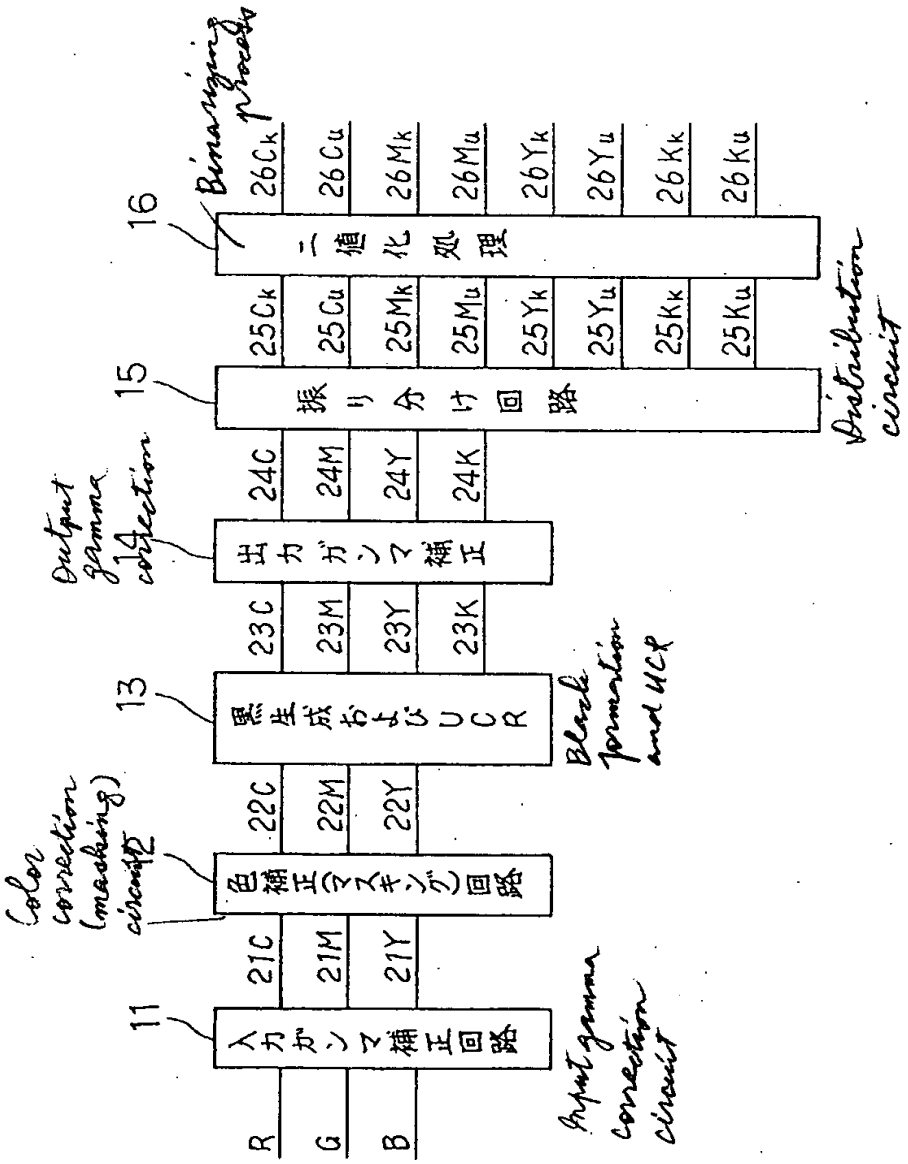
231 … contact point

【書類名】　図面　[Name of the Document] Drawing

【図１】　Fig. 1



【図2】 Fig. 2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G
B
11
入力ガンマ補正回路
Input gamma correction circuit
21C
21M
21Y
12
色補正(マスキング)回路
Color correction (masking) circuit
22C
22M
22Y
13
黒生成およびUCR
Black formation and UCR
23C
23M
23Y
23K
14
出力ガンマ補正
Output gamma correction
24C
24M
24Y
24K
15
振り分け回路
Distribution circuit
25Ck
25Cu
25Mk
25Mu
25Yk
25Yu
25Kk
25Ku
16
二値化処理
Binarizing process
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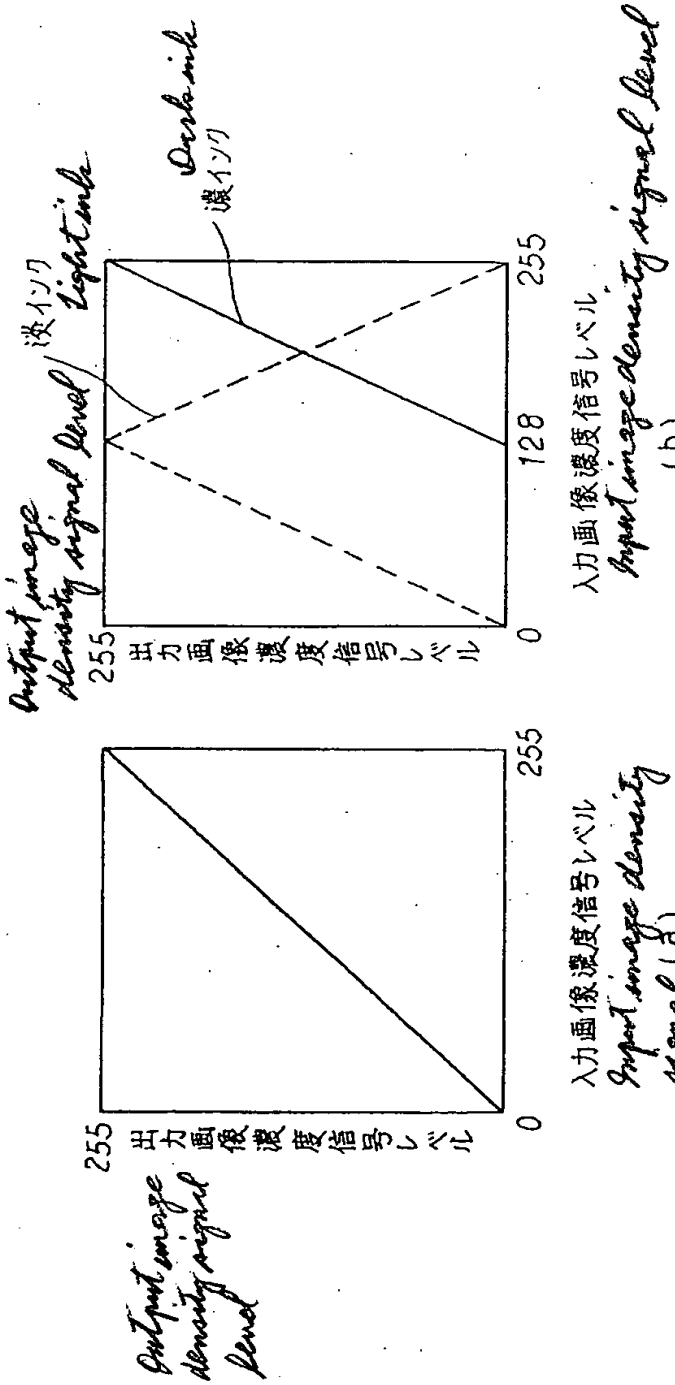
26Mu
26Yk
26Yu
26Kk
26Ku

【図３】 Fig.3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(b)
淡インク
light ink
濃インク
Dark ink
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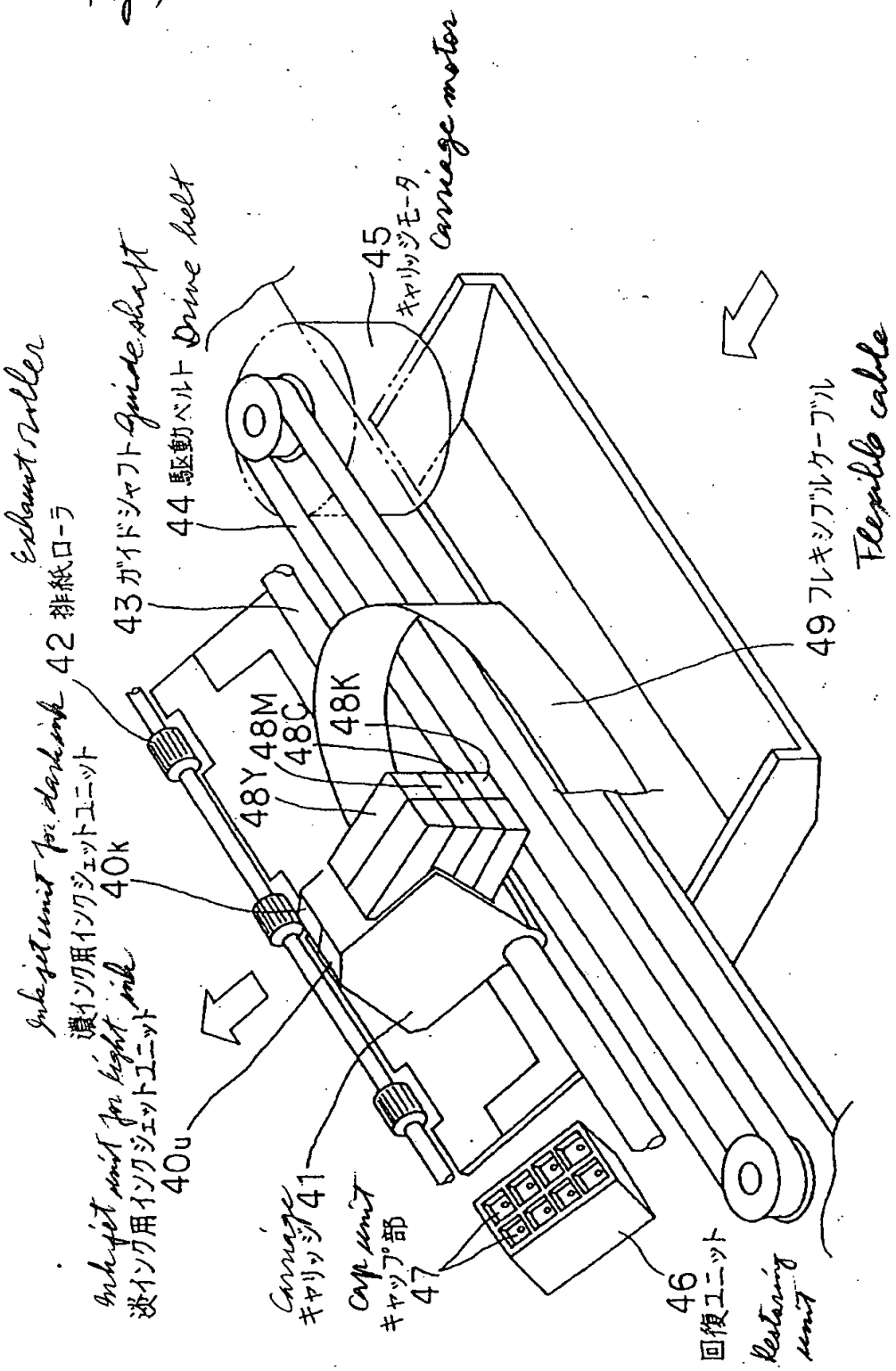
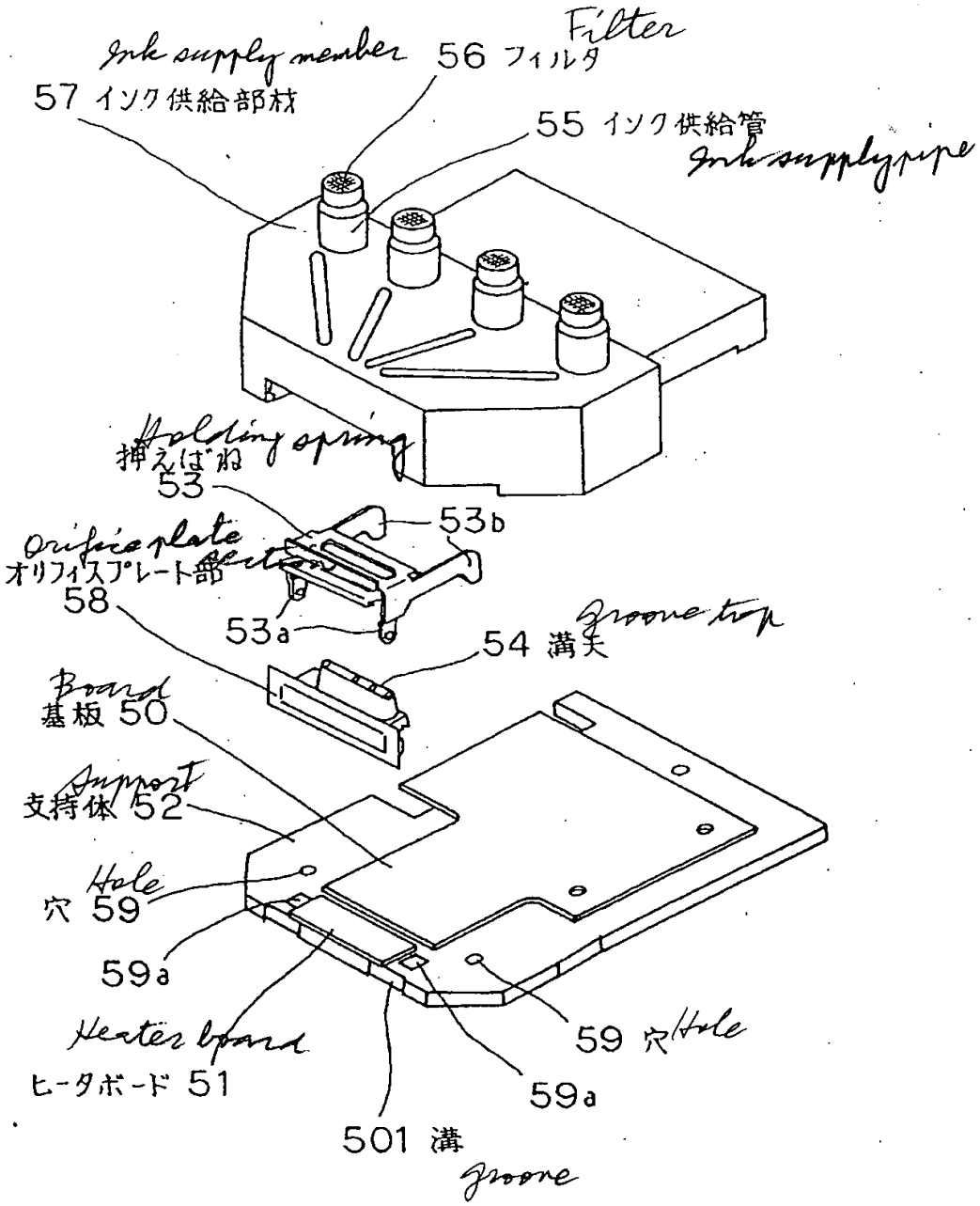
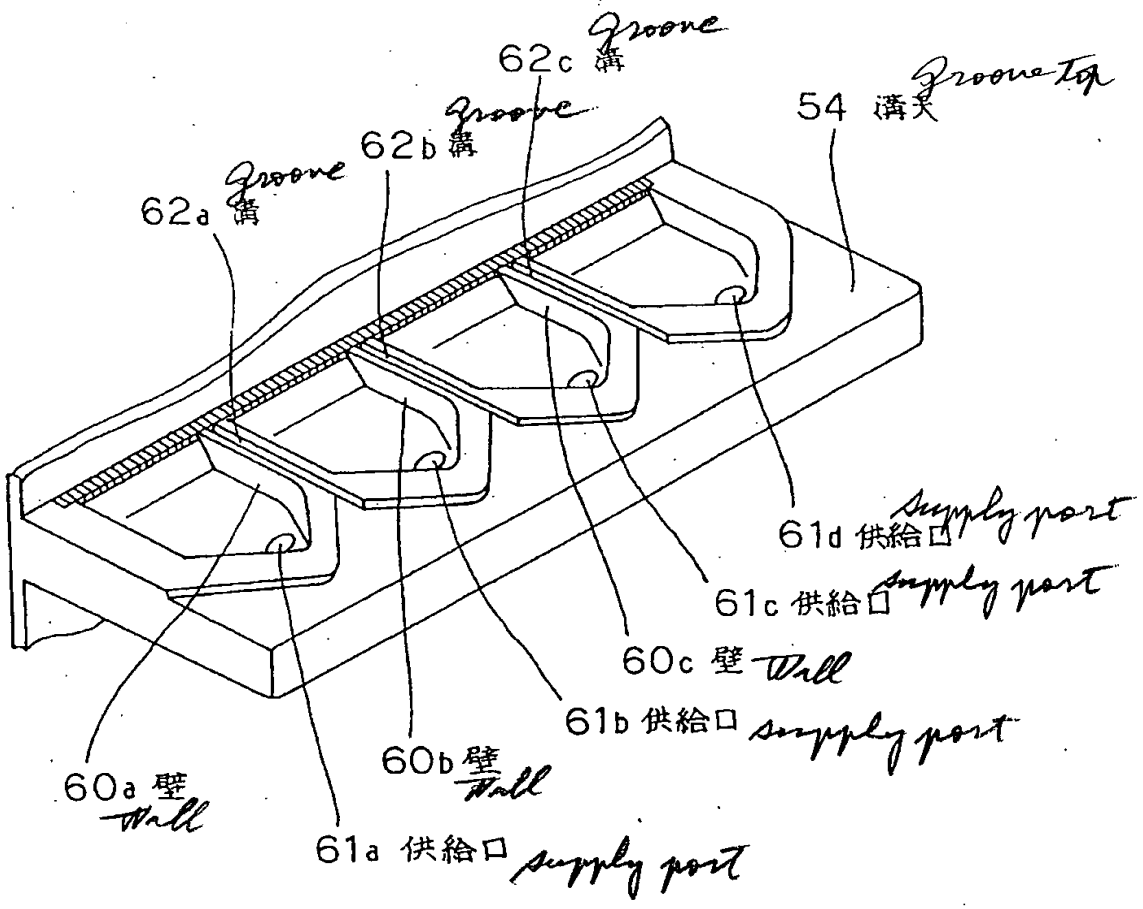
【図４】　Fig. 4


Exhaust roller
42 排紙ローラ
43 ガイドシャフト Guide shaft
44 駆動ベルト Drive belt
45 キャリッジモータ Carriage motor
49 フレキシブルケーブル Flexible cable
48Y
48M
48C
48K
濃インク用インクジェットユニット 40K
Inkjet unit for dark ink
淡インク用インクジェットユニット 40u
Inkjet unit for light ink
キャリッジ 41
Carriage
キャップ部 47
Cap unit
46 回復ユニット
Retaining unit

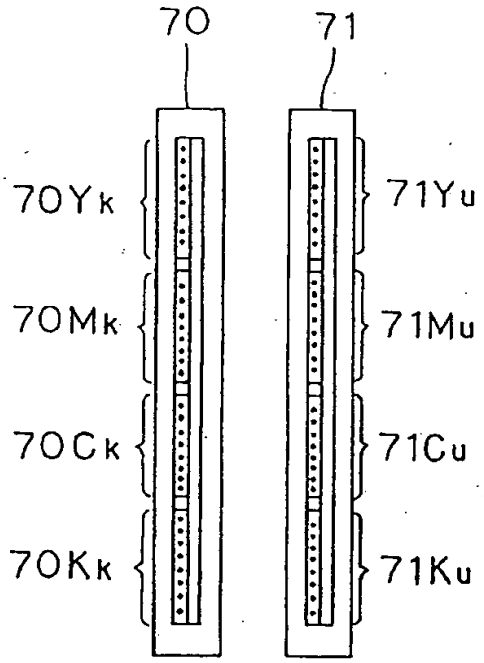
【図５】　Fig 5


Ink supply member
57 インク供給部材
Filter
56 フィルタ
55 インク供給管
Ink supply pipe
Holding spring
押えばね
53
53b
Orifice plate section
オリフィスプレート部
58
53a
54 溝
Groove top
Board
基板 50
Support
支持体 52
Hole
穴 59
59a
Heater board
ヒータボード 51
59 穴 Hole
59a
501 溝
Groove

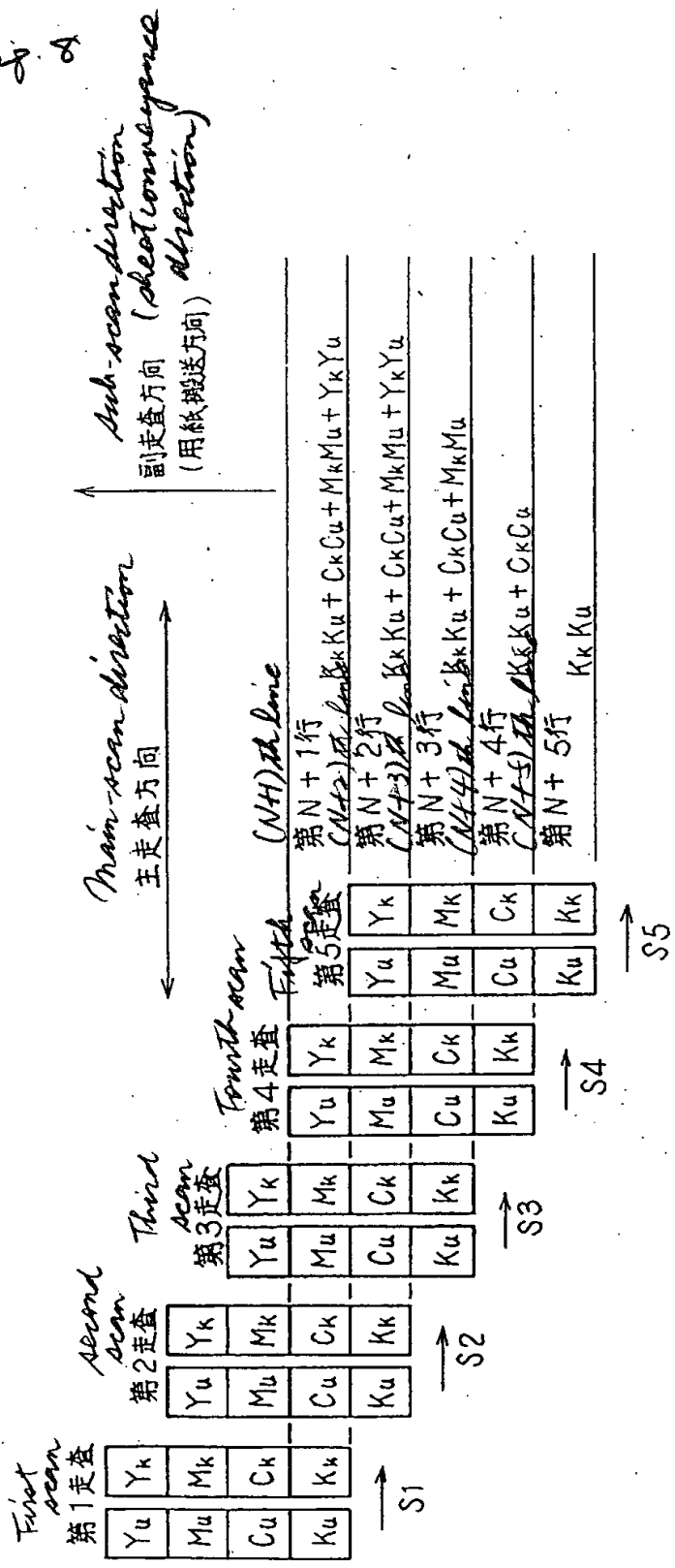
【図６】　Fig. 6


62c 溝 Groove
62b 溝 Groove
62a 溝 Groove
54 溝天 Groove Top
61d 供給口 Supply port
61c 供給口 Supply port
60c 壁 Wall
61b 供給口 Supply port
60b 壁 Wall
60a 壁 Wall
61a 供給口 Supply port

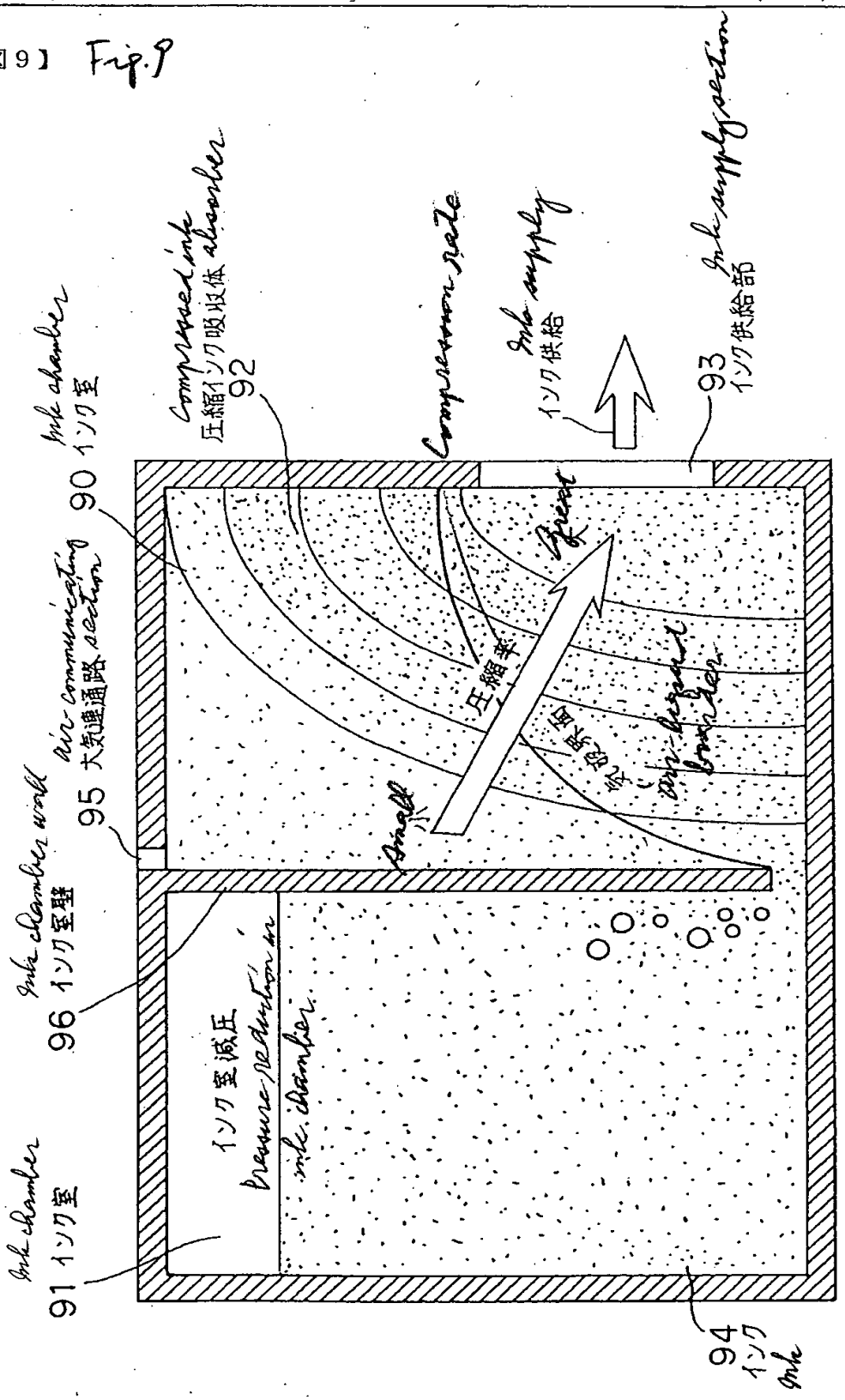
【図７】 Fig. 7



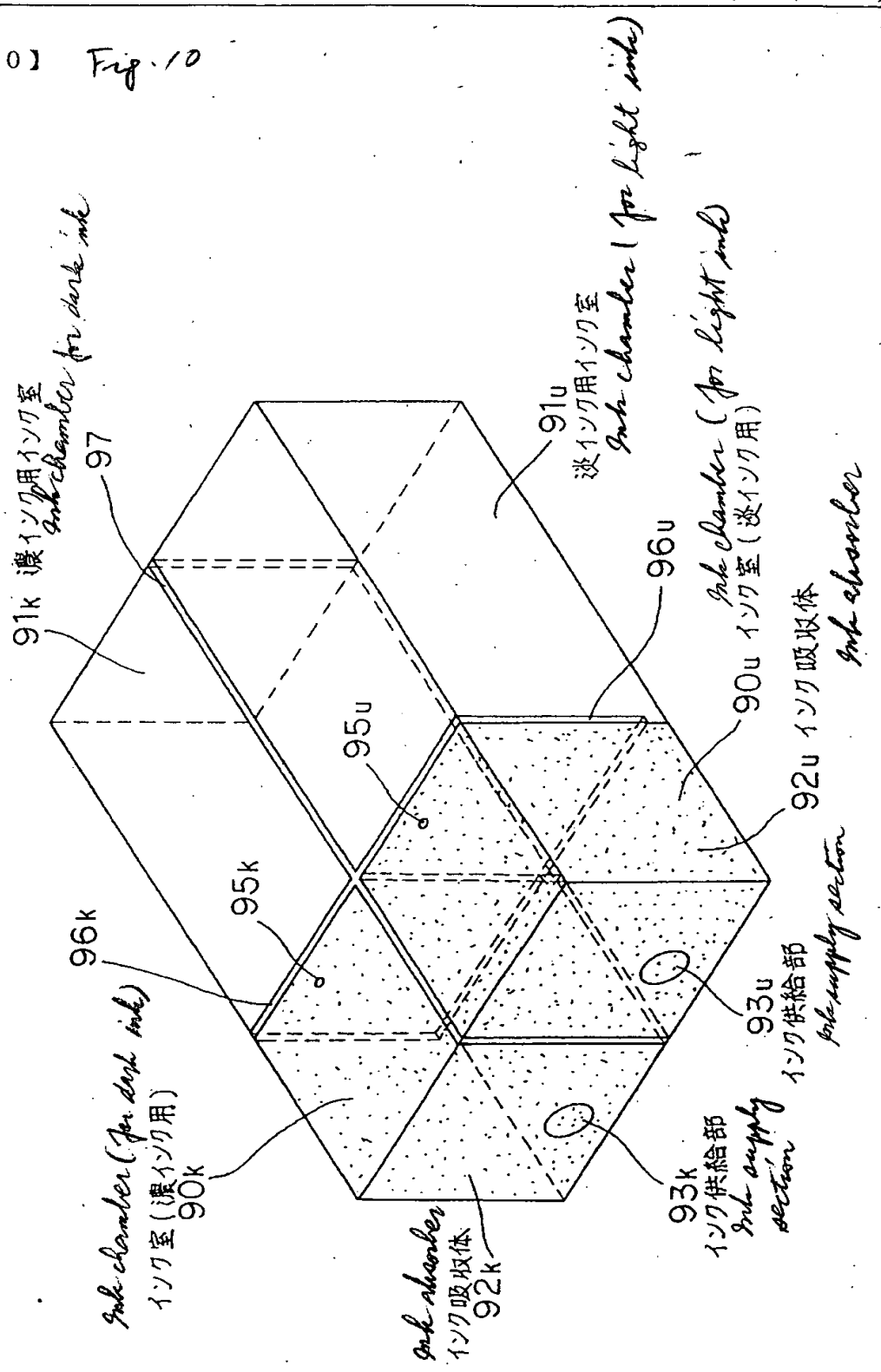
【図８】 Fig. 8


Sub-scan direction
副走査方向
(用紙搬送方向)
(sheet conveyance direction)
Main-scan direction
主走査方向
(N+1)th line
第N＋1行
(N+2)th line
第N＋2行
(N+3)th line
第N＋3行
(N+4)th line
第N＋4行
(N+5)th line
第N＋5行
First scan
第1走査
Second scan
第2走査
Third scan
第3走査
Fourth scan
第4走査
Fifth scan
第5走査
S1
S2
S3
S4
S5

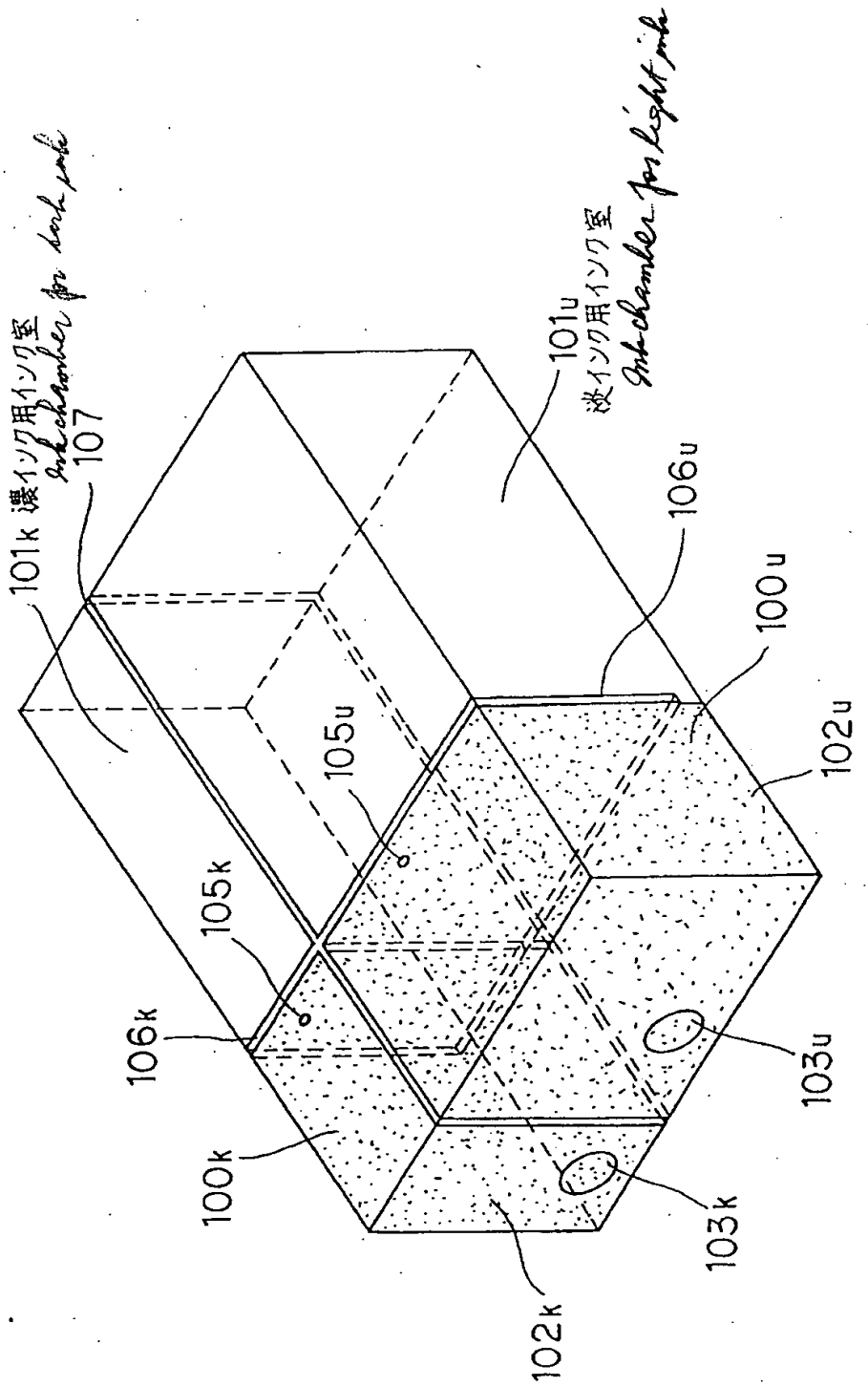
【図９】 Fig.9


Compressed ink absorber
圧縮インク吸収体
92
Ink chamber
インク室
90
Air communicating section
大気連通路
95
Sub chamber wall
インク室壁
96
Ink chamber
インク室
91
Pressure reduction ink chamber
インク室減圧
Compression rate
圧縮率
Small
小
Great
大
Sub supply
インク供給
93
Ink supply section
インク供給部
Ink
インク
94

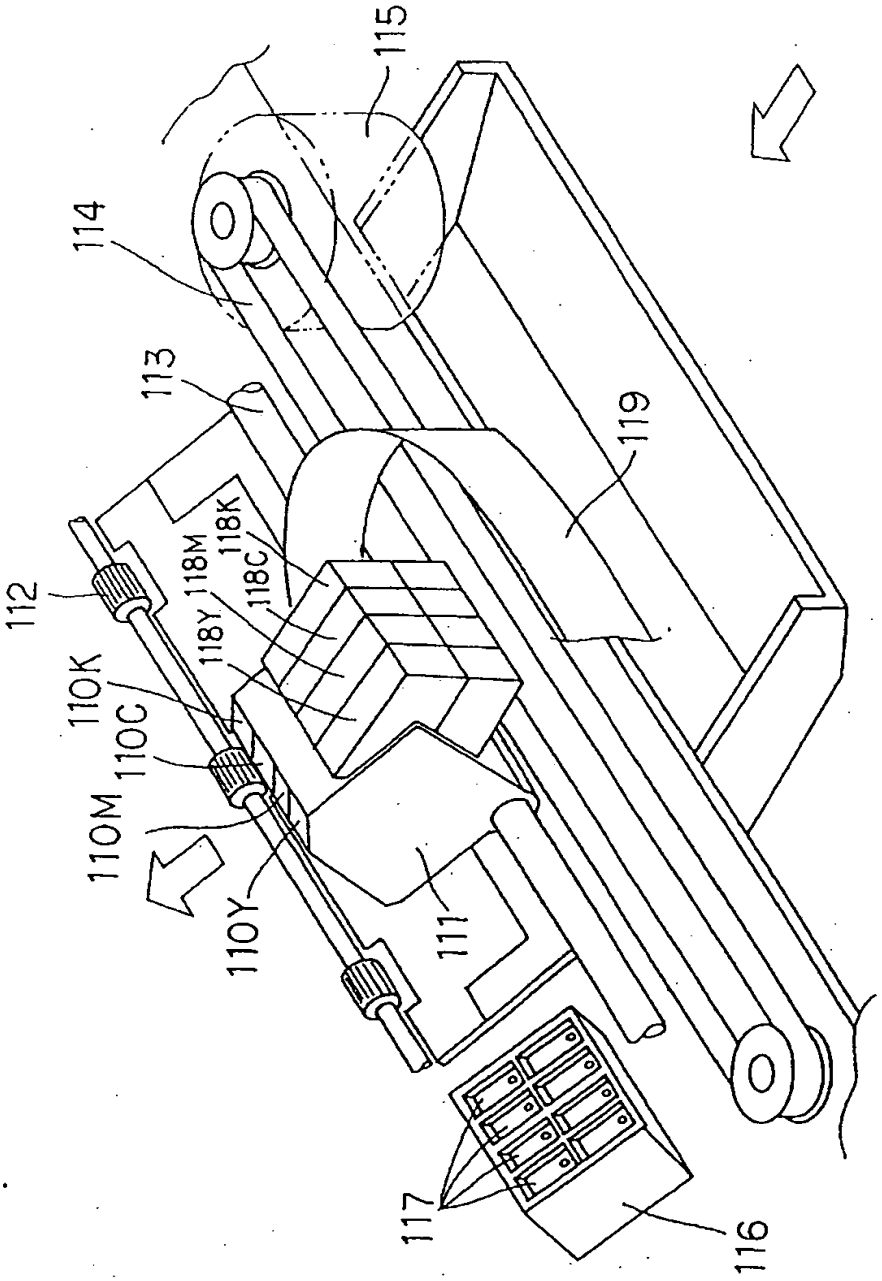
【図１０】 Fig. 10


91k 濃インク用インク室
ink chamber for dark ink
97
91u
淡インク用インク室
ink chamber (for light ink)
96u
ink chamber (for light ink)
淡インク室（淡インク用）
90u インク吸収体
ink absorber
95u
92u インク吸収体
ink absorber
95k
96k
ink chamber (for dark ink)
インク室（濃インク用）
90k
93u
インク供給部
ink supply section
ink absorber
インク吸収体
92k
93k
インク供給部
ink supply section

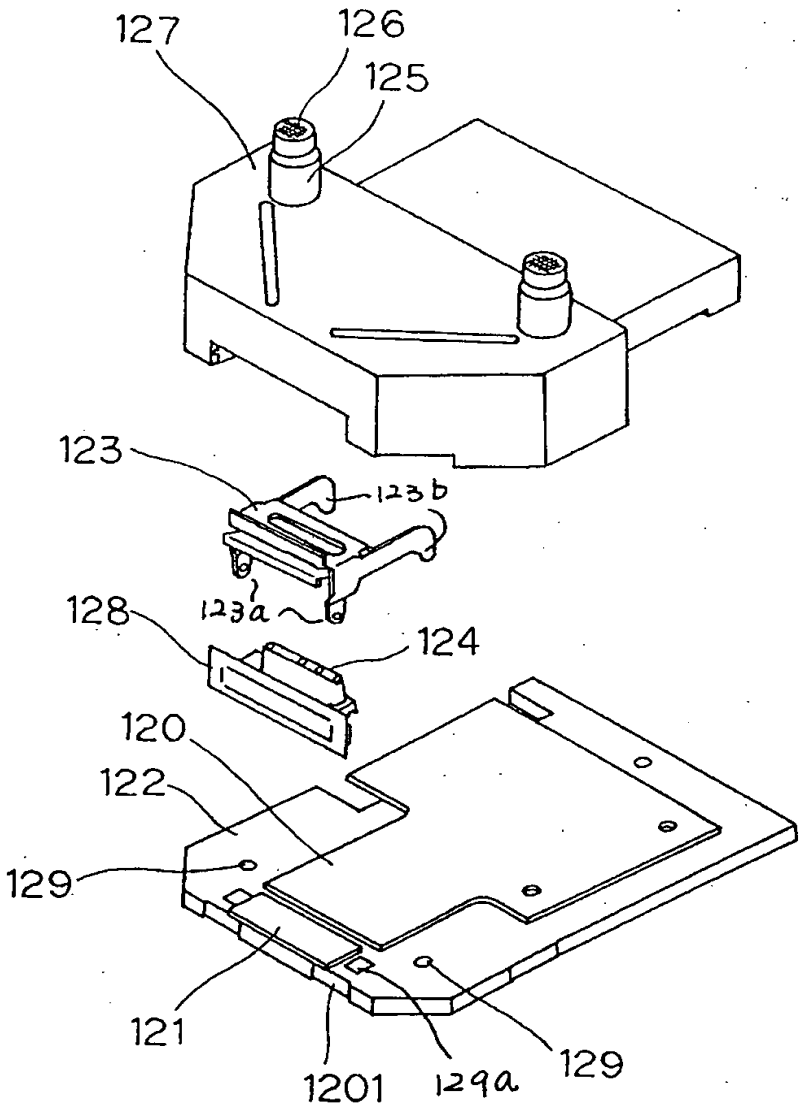
【図１１】 Fig. 11


101k 濃インク用インク室
ink chamber for black ink
107
101u
淡インク用インク室
ink chamber for light ink
106u
100u
102u
105u
105k
106k
100k
103u
103k
102k

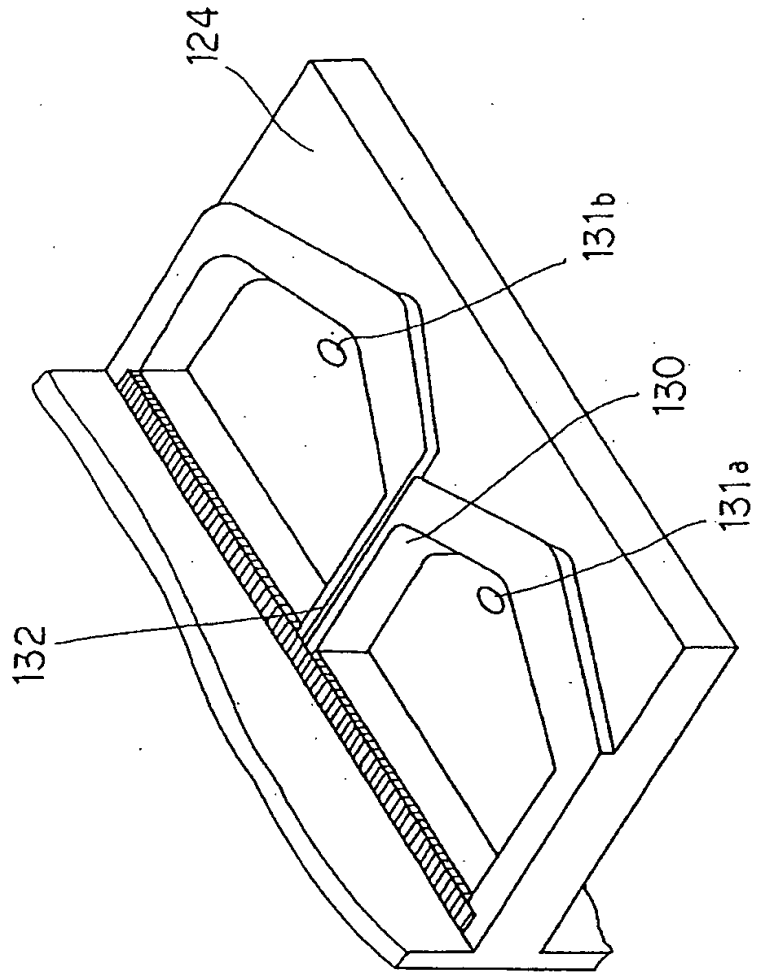
【図１２】 Fig. 12


115
114
113
119
112
118M
118K
118C
118Y
110K
110C
110M
110Y
111
117
116

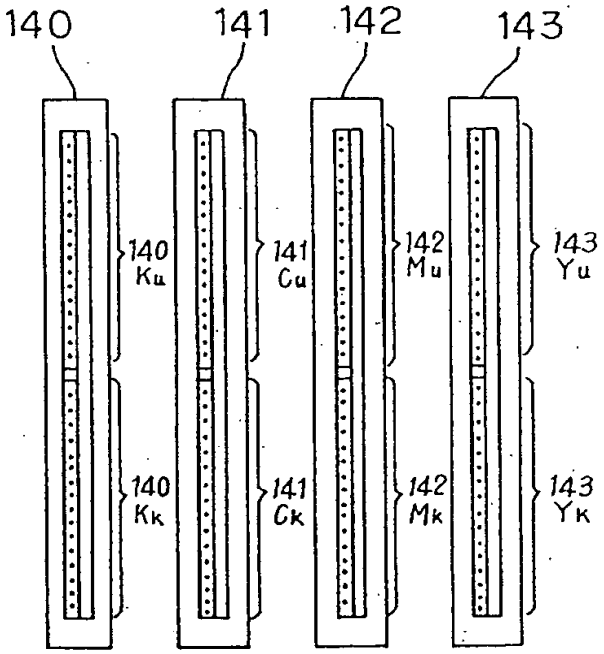
【図１３】 Fig.13



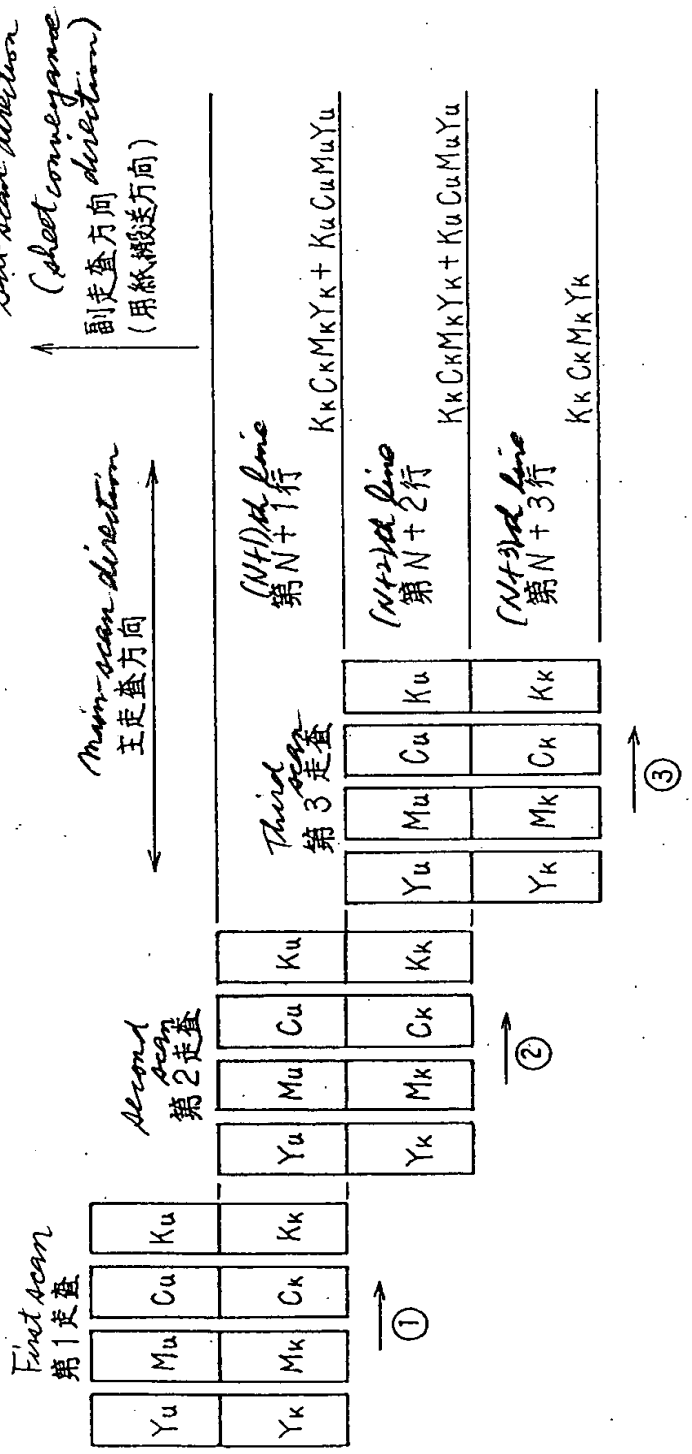
【図１４】 Fig. 14



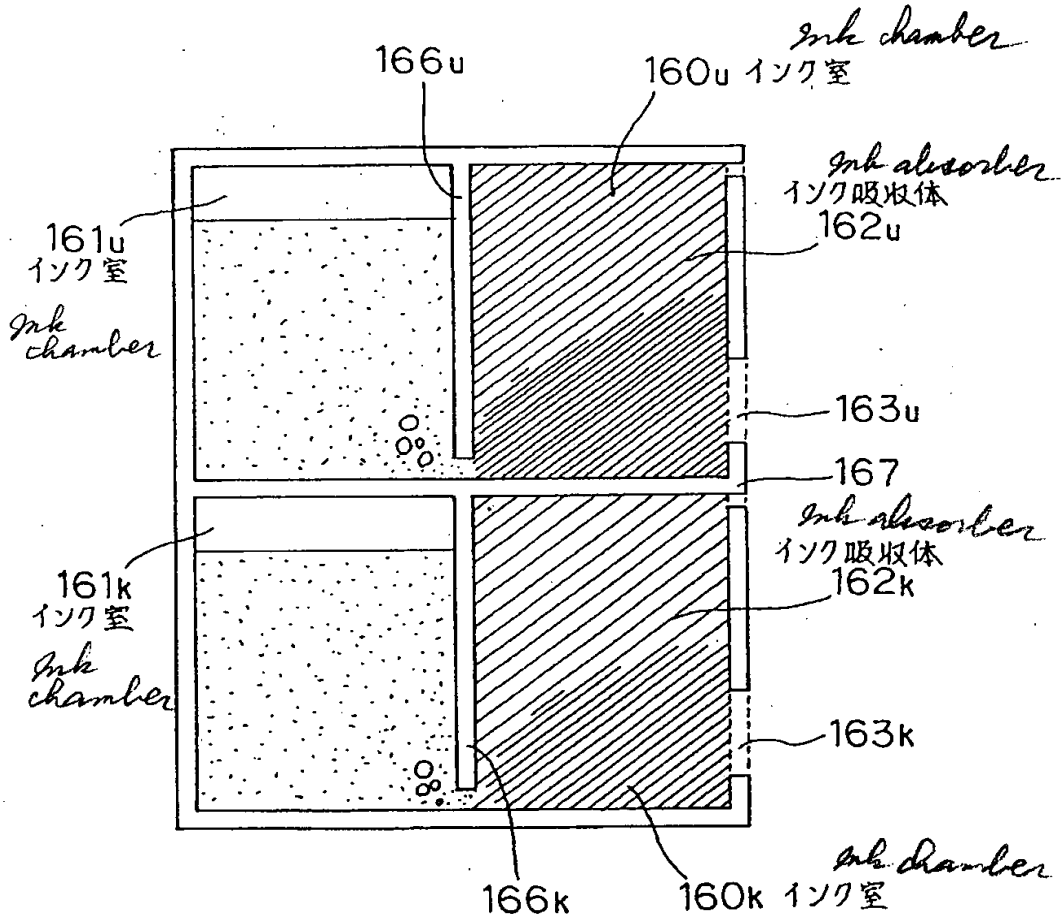
【図１５】 Fig. 15


140
141
142
143
140 Ku
140 Kk
141 Cu
141 Ck
142 Mu
142 Mk
143 Yu
143 Yk

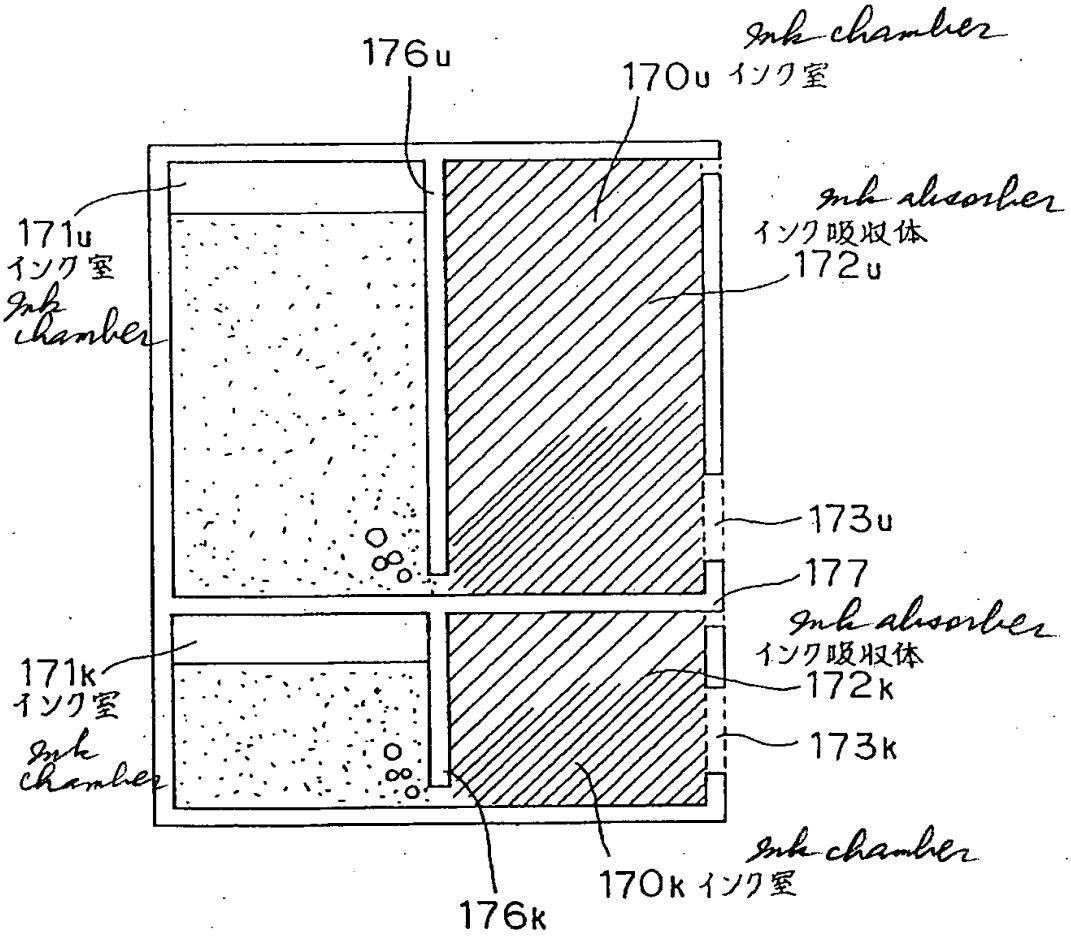
【図１６】 Fig.16


sub-scan direction
(sheet conveyance direction)
副走査方向
(用紙搬送方向)
main-scan direction
主走査方向
First scan
第1走査
Second scan
第2走査
Third scan
第3走査
(N+1)th line
第N+1行
(N+2)th line
第N+2行
(N+3)th line
第N+3行
Yu Mu Cu Ku
Yk Mk Ck Kk
KkCkMkYk + KuCuMuYu
KkCkMkYk + KuCuMuYu
KkCkMkYk
①
②
③

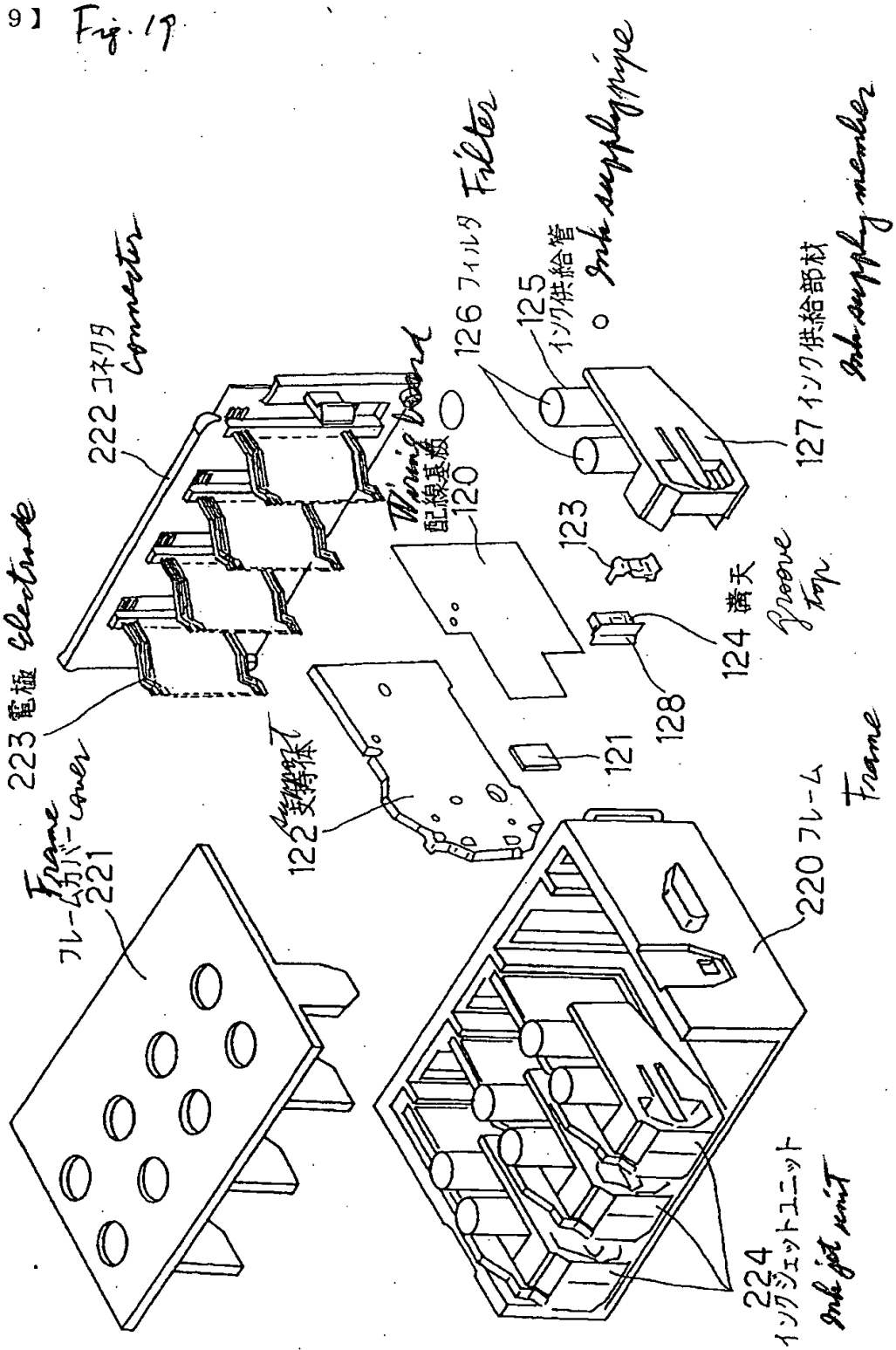
【図１７】 Fig. 17


Ink chamber
166u
160u インク室
Ink absorber
インク吸収体
161u
インク室
Ink chamber
162u
163u
167
Ink absorber
インク吸収体
161k
インク室
Ink chamber
162k
163k
166k
160k インク室
Ink chamber

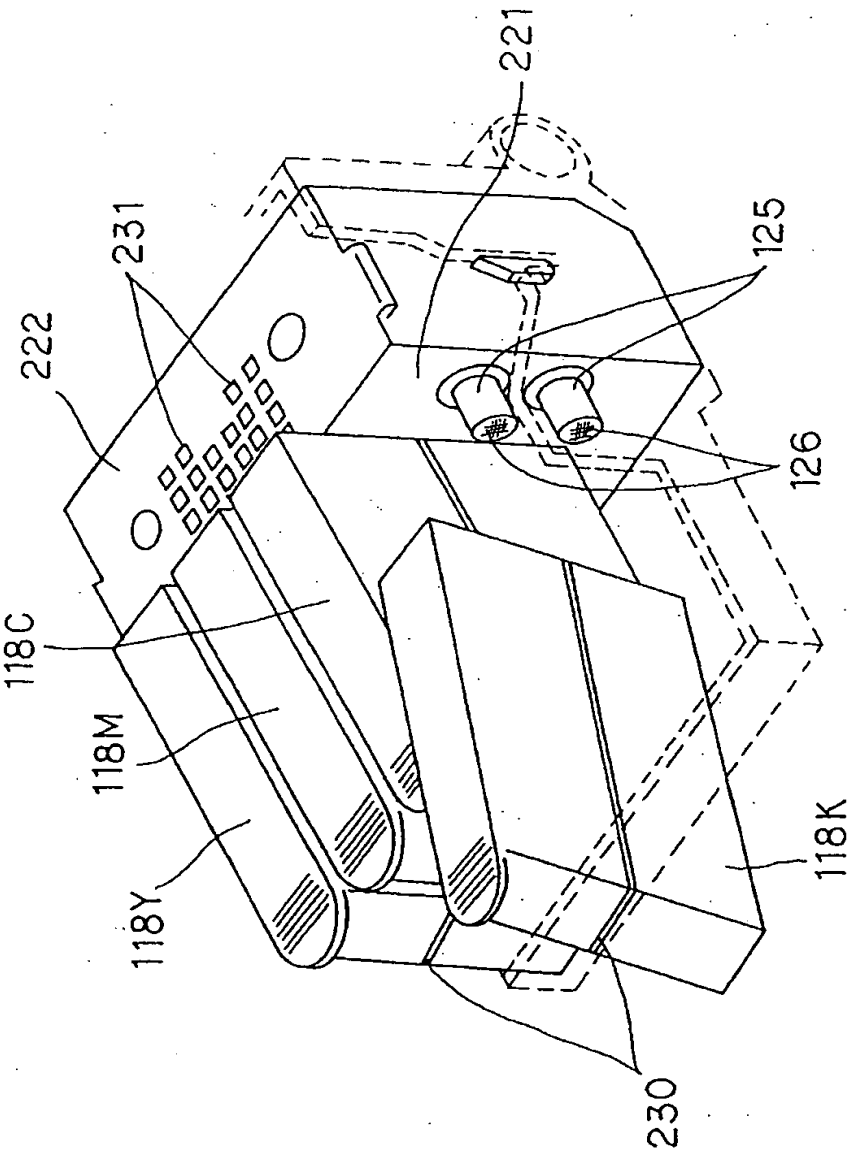
【図１８】 Fig.18


176u
170u インク室
ink chamber
ink absorber
インク吸収体
172u
171u
インク室
ink chamber
173u
177
ink absorber
インク吸収体
172k
171k
インク室
ink chamber
173k
ink chamber
170k インク室
176k

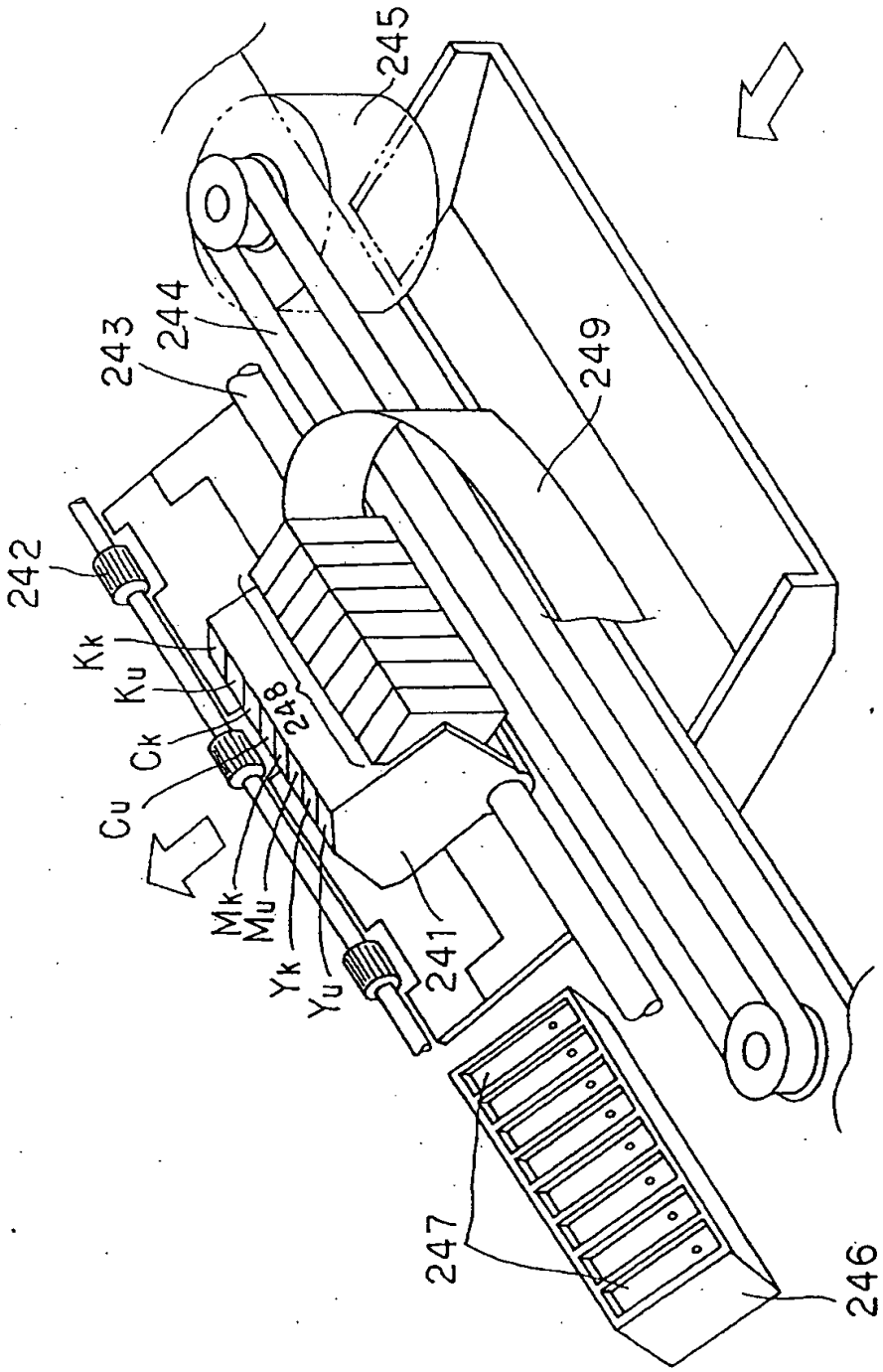
【図１９】 Fig. 19


222 コネクタ Connector
126 フィルタ Filter
125 インク供給管 Ink supply pipe
Wiring board 配線基板 120
123
127 インク供給部材 Ink supply member
223 電極 Electrode
124 溝天 Groove top
128
122 支持体
121
Frame カバー 221
220 フレーム Frame
224 インクジェットユニット Ink jet unit

【図２０】 Fig. 20



【図２１】 Fig. 21



[Name of the Document] Abstract

[Abstract]

[Object]

An object of the present invention is to provide a small-sized ink-jet recording apparatus which features excellent gradation and resolution and which is capable of producing an image with an extremely good graininess, to minimize the number of the ink cartridges.

[Constitution]

Disclosed is an ink-jet recording apparatus for using inks of at least two types of coloring materials, the ink of each coloring material being classified so that it has at least two different coloring material densities, having a plurality of ink discharge means for forming dots on a material to be recorded on by discharging the inks from the different ink discharge ports, which correspond to the plural inks, and controlling the number of recording dots per unit area, which are discharged onto the material to be recorded on in accordance with an image signal, thereby permitting gradational recording, characterized in that: the ink cartridges, which hold the inks to be supplied to the ink discharge means, is grouped by the ink of the same type of coloring material.

[Elected Drawing]

Figure 4